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TAMPERE UNIVERSITY OF TECHNOLOGY

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USER EXPERIENCE DRIVEN SMART CITY SERVICE DESIGN: TWO CASE STUDIES

Master of Science thesis

Examiner:
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ABSTRACT

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The goal of this thesis was to determine if two specific services are suitable for smart city concept. To determine what kind of services are suitable for the smart city concept, a literature review was done about the smart city concept. Based on the review, in general, smart city services are usually based on information and communication technologies, services that make sharing and access to information easier and ease communication between citizens, service providers and decision makers.

The services that are analyzed in this thesis were designed with companies involved in KÄPÄLÄ project. Tamware was designing a new Smart Hub concept to replace present bus stops and features for that design were gathered and prototype design tested with potential users. Citynomadi had finished a service for smart phones and internet that enables sharing and creation of routes with points of interest. Citynomadi wanted to find out new features and uses for their service for future versions of their service. The user studies made are described in this thesis and recognized design directions for services are described.

For both services, the study results revealed features that if implemented in finished products they would add services value as a smart city concept service. Before made into finished products both services should still be further tested after adding functional features to them. Testing with new features and design changes ensures that usability is maintained in new modified services.

TIIVISTELMÄ

JARI LAAKSONEN: Käyttäjäkokemuslähtöinen palveluiden suunnittelu älykkääseen kaupunkiin: Kaksi tapaustutkimusta
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Tämän opinnäytetyön tavoitteena oli määrittää kahden palvelun sopivuutta älykaupunki konseptiin. Jotta voitiin määrittää mikä on sopiva palvelu älykaupunkiin, suoritettiin kirjallisuuskatsaus älykaupunki konseptista. Katsauksen mukaan yleisesti älykaupungin palvelut pohjautuvat informaatio ja kommunikaatio teknologioihin, tekevät tiedon saatavuuden ja jakamisen helpommaksi ja parantavat kaupungin asukkaiden, palveluntarjoajien ja kaupungin päättäjien välistä kommunikaatiota.

Palvelut, joita analysoidaan tässä opinnäytetyössä, suunniteltiin yritysten kanssa jotka olivat mukana KÄPÄLÄ projektissa. Citynomadilla oli valmis palvelu älypuhelimille ja internetiin, jolla voi jakaa, ladata ja luoda reittejä joihin on liitetty kiinnostuksen kohteita. Citynomadi halusi selvittää uusia ominaisuuksia ja käyttötarkoituksia palvelulleen seuraavia palvelun versiota varten. Tamware suunnitteli uutta Smart Hub konseptia korvaamaan nykyiset bussipysäkit. Konseptille kerättiin ominaisuuksia ja suunniteltiin prototyyppi jota testattiin potentiaalisten käyttäjien kanssa. Tehdyt käyttäjätutkimukset ja tunnistetut kehityssuunnat kuvataan tässä opinnäytetyössä.

Molempien palveluiden tutkimukset tuottivat ominaisuuksia jotka sopivat älykaupunki konseptiin. Jos löydetyt ominaisuudet toteutetaan lopullisissa tuotteissa, ne lisäisivät palveluiden arvoa älykaupunki konseptin palveluina. Ennen kuin tuotteista tehdään lopullisia tuotteita markkinoille, tulisi vielä tehdä tutkimuksia lisättyjen ominaisuuksien kanssa. Uusien ominaisuuksien ja muutosten kanssa testaamisella voidaan varmistaa palvelun käytettävyyden hyvä laatu.

PREFACE

This Master of Science thesis is made for Tampere University of Technology. Cases in this thesis were done in co-operation with KÄPÄLÄ project, Citynomadi and Tamware. Work began on this thesis in November 2014 and it culminates my studies at TUT.

I want to thank KÄPÄLÄ project group, Citynomadi and Tamware for making this thesis work possible. I also want to thank all my co-workers at IHTE for support and creating a great working environment. Special thanks also should go to Kaisa Väänänen for supervising this thesis and my bachelor's thesis and employing me to work at IHTE for final years of my studies.

I also want to express my greatest appreciation and thanks to my parents for funding my studying patiently for so many years, my brother for relentlessly trying to help me with my studies and not frustrating at repeating same things over and over for many hours. Most of all I want to thank Annika, the love of my life, for patiently waiting for me to finish my studies and giving support for so many years.

I wish to use this chance also to remember my friend Veli-Matti Nyström (25.6.1984 – 1.3.2015). You were my very dear friend, who was with me through good and bad during my years studying at TUT, and you perished way too young.

Tampere, 12.7.2015

Jari Laaksonen

CONTENTS

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LIST OF SYMBOLS AND ABBREVIATIONS

ELY-Center	Centre for Economic Development, Transport and the Environment
ICT	Information and Communication Technology
KÄPÄLÄ	User Experience Driven Services for Smart City
NFC	Near Field Communication
QR code	Quick Response Code
TREDEA	Tampere Region Economic Development Agency
TUT	Tampere University of Technology
UCD	User Centered Design
USB	Universal Serial Bus
UTA	University of Tampere
UX	User Experience
VTT	Technical Research Center of Finland
WLAN	Wireless Local Area Network

1. INTRODUCTION

Smart city is a concept where communication and interaction between citizens, service providers and decisions makers is made easier and more efficient with information and communication technologies. Smart city can provide services more efficiently, more ecologically and react to it inhabitants needs more precisely. This allows smart cities to thrive better than regular cities without smart solutions. Because smart city services should work toward these concept goals the users of the service must be taken in consideration while designing them. For example Mulligan and Olsson [14] describe that the key thing in smart city solutions is to get citizens involved and approaches that have linked citizens directly to technology and application development have been extremely popular and successful.

This master's thesis describes how user-centered design methods were implemented in two cases to produce design choices for services suitable for smart city context. To give readers clearer idea of what smart city concept means literary review of smart city definitions is provided and examples of smart city cases and technologies are presented. There are also short descriptions provided of different user-centered design methods used during the cases to give readers some basic background knowledge about them.

The first goal for writing this master's thesis were to find out definitions for smart city and what features are connected to smart city concept. This goal was set so that second goal for this master's thesis can be fulfilled. The second goal for this master's thesis was to analyze two services suitability to smart city concept. These services features were designed using user-centered design product development methods during two cases connected KÄPÄLÄ (User Experience Driven Services for Smart City) project.

This document is structured as follows. Chapter 2 describes in general smart city concept and features and technologies connected to it. Chapter 3 shortly introduces methods that were used with cases involving this thesis. Chapter 4 describes the KÄPÄLÄ project and two cases done during the project and the cases connections to smart city concept. In chapter 5 evaluations of the cases and overall process is presented. Chapter 6 summarizes all together with conclusions and discussion. Interview questions used in user studies and numeric findings are included as appendixes.

2. RELATED WORK ON SMART CITY

This chapter's intention is to give readers general idea what is meant with the term smart city. There are collection on definitions and features connected to smart cities and then few technology and case examples.

2.1 Smart City Definitions

According to literature smart city concept has no one clear definition [3,16] but instead it has roots in different city development concepts and smartness of city can be defined with few different ways based on the definition that is used. In this chapter is collected different ways to define the smartness of city and few previous concepts that according to literature have been contributing to development of smart city idea.

When talking about smart cities there are often also references to similar concepts like intelligent city, city 2.0, WikiCity, urban intelligence, ambient city, real-time city, ubiquitous city, digital city. According to Roche [18] all these terms have in common that they refer to city that is improving its urban functions and services with combination of networks, sensors and active citizens. Schuurman et al. [20] argues that smart city is more user-centered evolution of other concepts. Nam and Pardo [15] divides smart cities conceptual relatives according to three dimensions they are related to smart city. According to Nam and Pardo [15] technology wise relative concepts are: Digital City, Intelligent city, Ubiquitous city, Wired city, Hybrid city and Information city, People relative concepts are: Creative city, Learning city, Humane city and Knowledge city, and community relative concept is Smart community. Wang et al. [24] defines that smart city concept is based on digital city concept and internet of things. Nam and Pardo [15] also defines term smart so that the meaning of smart in smart city is that smart is more user friendly than intelligent, smart city needs to adapt itself to user needs. Ferreira and Afonso [6] mention that smart city should point to clever solutions that allow modern city to thrive through qualitative and quantitative improvements in productivity. Su et al. [22] describes that smart city is an approach to smart planet concept in specific region. Digital city takes remote sensing, global positioning, geographic information systems and spatial information technologies as core functions. Smart city is product of digital city combined with internet of things. Smart city builds on digital city adding measurable urban management and operations intelligently to it.

In general there are aspects of smart city that are agreed on in different definitions. Smart city definitions have in common their connections to use of information and communication technologies (ICT) that help the coordination on information and use of

resources more efficiently [3,6,16,18,19,24]. According to Komninos et al. [10] smart cities need advanced internet-based services and open user driven innovation environments to answer the needs for their people, companies and public authorities. With smart cities comprehensive city planning and good use of heterogeneous data offered by ICT can be utilized to control city functions better and more efficiently. By collecting and analyzing data from many different ICT sources cities can start recognizing patterns for different conditions that can be improved. According to Caragliu et al. [3] ICT technologies can utilize network infrastructure to improve economic and political efficiency. Roche [18] sees smart city concept still to be in development and notes that it aims at efficient infrastructure and optimized routine city operations based on ICT. Wang et al. [24] describes that smart city comes from accelerated development of new information technology and knowledge-based economy and is based on combination of different types of networks.

Other common aspect in many smart city definitions is based on human capital and education, social and relationship capital [3,6,16,19]. According to Neirotti et al. [16] technology by itself is not sufficient enough to transform cities to smart cities so need for capable human capital is needed to make decisions and improve cities livability. Smart cities should use information to optimize city services from waste management to energy distribution. Smart cities should also give access to available information for it citizens to use so people can make their own decisions and have a chance to influence their own living surroundings [16]. Kominos et al. [10] suggest that to make use of it human capital smart cities could use methods like crowdsourcing, online collaboration, people-driven innovation and smart environments. Salem et al. [19] defines smart city to be built around its citizens by advanced ICT solutions and advanced sensing. This helps the exchange of personalized information to and from citizens to support their needs and enables citizens to build smarter city for themselves. Caragliu et al. [3] mentions that smart city community has to be able to learn, adapt and innovate, and to achieve this people need to be able to use technology. Roche describes that [18] smart city supports active urban citizenship with participatory involvement of all actors and creates methods to govern through information, open services and open data.

Urban growth is also agreed to be important aspect of smart cities [3,6,15,16]. Caragliu et al. [3] focuses on literary review about smart urban growth from economist's perspective and empirical exploratory analysis. With ICT urban, social and cultural development can be enabled to support growth in smart cities [3]. Smart cities should also have business-lead urban development because according to Caragliu et al. [3] business-oriented cities tend to have satisfactory socio-economic performance. Especially high-tech and creative industries are beneficial to urban growth because they attract creative and skilled workforce to cities hence adding value to its human capital and increasing value to aspects effecting smart cities success [3]. Caragliu et al. [3] describe that social and urban sustainability is a major strategic component and a

cornerstone of urban development. Nam and Pardo [15] connect growth to smart city by writing “City is smart when investments in human/social capital and IT infrastructure fuel sustainable growth and enhance a quality of life, through participatory governance”. Nam and Pardo [15] also describe that in urban planning smartness means that government and public agencies should embrace sustainable development, economic growth and better quality of life for their citizens.

Hernández-Muños et al. [7] identifies smartness of city with six dimensions which are economy, people, governance, mobility, environment and living. Caragliu et al. [3] says that city is smart when it invests on human capital, social capital, transportation and modern ICT that fuels sustainable economic growth and high quality of life. Caragliu et al. [3] also define that smart city needs wise management of natural resources through participatory governance. Roche [18] studies smart cities through spatial enablement and it defines that smartness of city should be measured by its ability to offer favorable conditions to citizens, organizations and other urban operators to be actively involved in socio-spatial innovation dynamics. Caragliu et al. [3] notes that there are correlation between the accessibility of the city and the wealth of the city and that attraction of the destination city increases with it size and accessibility, and declines with distance, costs and travel time. From this notion the conclusion is drawn that better transportation means might increase cities wealth and growth [3]. Wealth also increases with the availability of public transportation in the city [3]. Salem et al. [19] describe that smartens of city is not only based on ICT, but also on transportation, human and social capital, natural resources, regional competitiveness and citizen participation in governance decisions. Su et al. [22] describe that smart city can intelligently respond for example to needs of daily livelihood, environment, public safety and city services. Nam and Pardo [15] define that smart city is built on three main dimensions: technology, people and institutions.

Key features of smart city:

- Efficient use of ICT
- Communication between citizens, service providers and decision makers
- Use of different sensors to gather data about different city aspects
- Efficient analysis and use of data gathered around the city
- Human capital, education, social and relationship capital is important
- Growth of the city should be sustainable
- Good accessibility and efficient public transportation
- City should be able to adapt to user needs
- Natural resources and ecology should be taken in consideration

2.2 Smart City Technologies and Cases

Mulligan and Olsson [14] focus on smart city problem solutions that enable city to improve its delivery of services to users and reduce the environmental impact. According to Mulligan and Olsson [14] smart city service ideas are based on ICT industry solutions and telecommunication solutions and both have their own take on architecture perspectives. Because of this to get best solutions for smart cities strengths form both architectures should be integrated together. Big ICT companies have started to invest on smart city technology solutions and many solutions on the field are based on collecting large data sets and analyzing them. These solutions are usually re-applications of systems and architectures originally designed for corporations and that is why they focus usually on efficiency. According to Mulligan and Olsson [14] problem is that these kind of smart city technologies that don't take in consideration the end user and their privacy are unlikely to achieve acceptance. Mobile network operators have better position to create smart city solutions in terms of having already access to user identities and movements through their mobile devices but their data still lack the social context that would make it most useful for smart city solutions. The key thing in smart city solutions is to get citizens involved. Approaches that have linked citizens directly to technology and application development have been extremely popular and successful. These solutions are still limited by existing boundaries of available data for developers and this creates important pressure to government and other actors with data to start delivering it on open formats. Many business models for smart cities are based on large and broad amount of data linked to individuals and architecture wise the problem is how to do this with low enough costs to make it profitable. Mobile network architecture and ICT need to work together to make this work and at the same time protect the end users privacy. Also it is necessary for smart city applications to work that the data is correct and can be trusted. New devices must be connected to mobile and fixed networks to make smart city work. Networks that were originally designed for phone calls and set sized SMS must also adapt to handle this increasing load of multiple devices and sensors sending small amount of data infrequently through it to synchronize data. To make smart city technologies work and accepted by the users, users should be able to have privacy settings on data concerning themselves. With this, service providers could be sure that data they receive is correct through authentication mechanisms, and users would have more secure feeling about using services, when they have some control over their information. [14]

Mulligan and Olsson [14] present a mobile client that can be used for citizen participation in decision making by offering location-based polling about issues in the city. This system needs utilization of many communication technologies and services so that the governance and citizens can get full benefits from it. Smartphones have great potential for delivering personalized services, involving citizens in urban planning and contribute to urban sensing because mobile technologies are considered to be more

evenly distributed across society than wired technologies, and usually used by particular citizen so services can be personalized more. Mulligan and Olsson [14] describes a participatory urban sensing concept where urban planning polls can be associated with geographical locations. Citizens can register with their mobile devices to the system and then they are polled when they are in the vicinity of the area under development. Results from the polls are delivered to municipal agency and the participants after the poll is closed. This concept enables location-based polling and collaborative decision making. [14]

Cardone et al. [4] tell in their article about system designed for urban crowd sensing. Crowdsourcing is a situation where problem is divided into smaller tasks and solved by collective intelligence of crowd. Crowd sensing is collecting information via crowd from selected surroundings. Article describes a McSense mobile application that gives users a task and promises small monetary incentive for completing the given task. Using mobile crowd sensing can be cheaper and easier to setup than fixed data collection points placed at the areas of interest. The crowd sensing system can be seen in Figure 1 and it has three parts: a task console, mobile application and data backend. With the task control console tasks are given to the system with preferred parameters. Mobile application communicates the location and other relevant information about the people who have the application so that tasks can be offered to people relevant to the tasks. Finally data backend collects information from mobile applications, process the information and send the processed data back to the control console so it can decide when tasks are completed. Monetary compensation was selected for incentive to users because some task given might use the battery of the mobile device faster than normal and users are more forthcoming to attend in data collection when they receive something in return. [4]

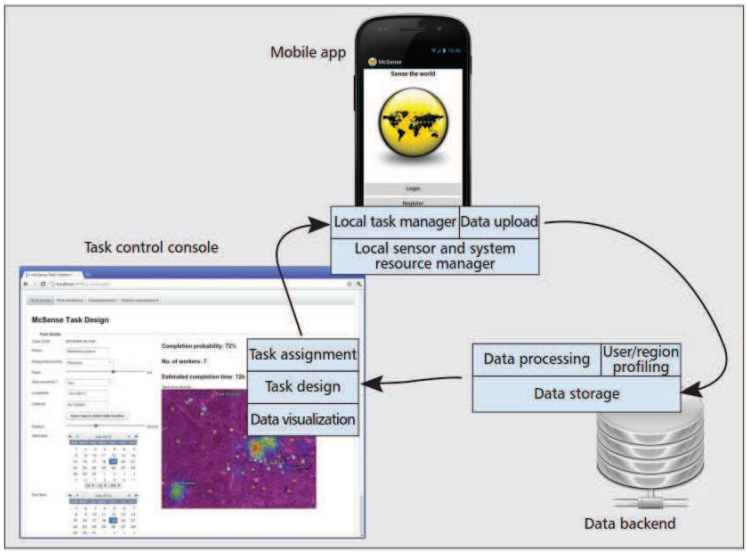

Figure 1. *The McSense distributed architecture for crowd sensing [4]*

Mitton et al. [13] describe in their article how clouds can be used with sensors and crowd sensing giving new opportunities for contextualization and geo-awareness of data. Users and community groups need to be involved in social networks to document their lives and participate in document collection. Data sharing by independent public and private organizations increase effectiveness and efficiency of smart city services. Amount of different type of devices and technologies limit the integration strategies and there is a need for unified architecture for data sharing that is highly scalable and easy to setup fast. [13]

Kim et al. [9] describes an energy management system that helps non-professional and professional consumers to be more energy aware with their consumption. It is a web-based application that suggests energy management decisions to users via user friendly interface. To build energy-ecosystem it is crucial to involve energy suppliers, policy makers and citizens. To handle massive amounts of data collected by sensors data needs to be optimized and have strong referential integrity to accommodate possible future requirements for it. For this there is a need for a database and the system also needs to implement functionalities of data warehouse on top of it energy management functionalities. [9]

Park et al. [17] describe in their article that in smart cities the aim is that citizens can use variety of it services anytime and anywhere and this means that usually services need to process large amounts of data. In Korea they try to solve the problem of large amount of data processing with cloud computing techniques and offer citizens access to services via android smart phone application. [17]

Ferreira and Alfonso [6] describe smart mobile application designed for electric vehicle users in smart city to provide information for decision and mobility purposes. Managing electric vehicles needs coordination with electrical distribution network. System also needs data analysis on energy consumption, information about vehicles batteries discharging or charging process and coordination between several users and energy producers. Information system is important in information society for this purpose the application offers diversity of functionalities. Application provides information about positioning, public transportation, available parking, points of interest, car and bike sharing and current energy market prices. With the application user is able to determine best choice for transportation between two points. Application can calculate weights for travel time, parking, car charging, and other costs and suggest the best option for travelling via private car or public transportation. [6]

Su et al. [22] tell how smart cities technical architecture can be divided in three layers. One is the perception layer that identifies different objects and collects information. Second is the network layer that accurately transmits and processes information from perception layer. And third is the application layer that analyzes and processes large amount of data and information through cloud computing. Building smart platform for

smart city needs construction of network infrastructure, cloud computing platform and construction of sensor network. On top of this smart platform application platform can be build that can include constructions of wireless city, smart public services and social management, smart transportation, smart urban management, green city and smart tourism. One difficulty when building a smart city comes from managing massive amount of urban spatial-temporal data that requires multi-dimensional temporal data model which has flexible structure and is also adaptive. Other challenge is to break information barriers so that information sharing and exchange is more open between city departments and companies providing different services. [22]

Schuurman et al. [20] study crowdsourcing for generating and selecting ideas in smart city context. According to Shuurman et al. the importance of citizen involvement is agreed by scholars and policy makers to be a key for successful development of cities and that is why they study online crowdsourcing. They describe online crowdsourcing case study for creating and selecting innovative ideas for smart city and compare the results to ideas created and selected by professionals. With crowdsourcing compared to regular in-house development more heterogeneous group can be compiled for innovation. With the crowdsourcing platform citizens and experts were asked how citizens' everyday lives could be made easier with ICT. In innovative sense ideas generated with crowdsourcing were not very innovative so idea creation is not especially useful use of crowdsourcing. Ideas selected with crowdsourcing produced significantly more user benefits than selections made by team of experts. This shows that crowdsourcing is good way to find what services citizens should be offered. [20]

Liu and Pan [11] studied smart travel in a city that is part of smart city concept. They determine what points need improvement in Nanjing to make tourism services better. They state that making tourism services better enables not only higher tourism revenues but it also improves city's reputation and resident peoples quality of life. They conducted different research methods linked with user experience and service design including heuristic evaluations, expert interviews, fixed point observations and shadow tracking. To analyze the results they used affinity diagrams and customer behavior maps. When designing and analyzing smart travel services travel can be divided in three parts that all should be considered: before travel, during travel and after travel. The aspect that affect the travel and things that need improvement can be categorized based on their importance to must be factors, functional factors and attractive factors. [11]

Summary of aims of smart city technologies:

- Citizen involvement in development is important
- Software architecture solution to help information transfer
- Data models to help unify information computing from different sources
- Combining wireless and wired network technologies
- Easier access to services

- Information about the city available real time
- Mobile solutions to connect citizens to city
- Using citizens as sensors
- Crowdsourcing

3. USER EXPERIENCE DRIVEN DESIGN METHODS IN THE CASES

In this chapter different methods are described concerning the thesis which are used during the cases described in the next chapter. Methods and theories are described on general level as guidelines and they were somewhat modified to fit the cases specific needs when implementing them to get the best results.

3.1 User-Centered Design

User-centered design is based on the idea of involving users in the design process. There are several different user centered-design methods and the amount of user involvement and phases where users are involved vary from method to method. The general goal is to understand the users view on things and design service or system so that it supports the users existing mental model on how the service should work thus making the service or system easier to adapt by the user.

To better understand users with UCD use cases can be made about the use of the service to describe what steps the user takes when using the service [21]. Use cases can help find problem points from the service that need extra attention when designing it. Scenarios can also be used to describe the service use and they help the design team to communicate while designing the service. Scenarios describe the context and tasks that are done with the service and they can be used for example to describe situations during tests for users. Personas can be used to describe generic typical user group member for the service. Personas are made from each potential user group and describe their needs and features that should be taken in consideration in the design.

3.2 User-Centered Design in Product Development Cycle

UCD product development is divided in five stages which are: user analysis, conceptual design, implementation, piloting and on the market. And because method is a cycle it is started from the beginning again when product has reached on the market stage and the product iterated and developed further.

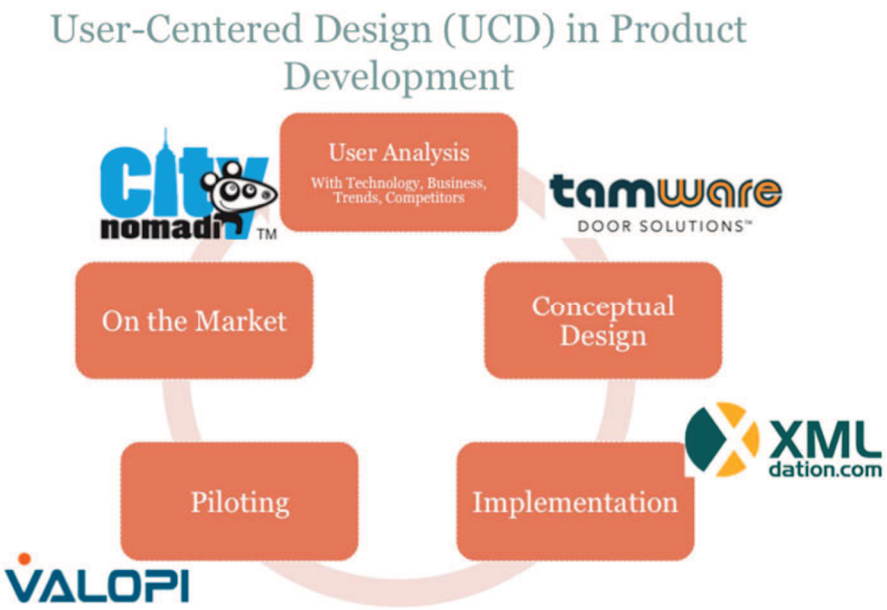

Figure 2. *User-Centered Design in Product Development Cycle*

In KÄPÄLÄ project companies involved were placed, according to their needs for their products, in the user-centered design (UCD) product development cycle. Figure 2 show the cycle and companies placements involved in KÄPÄLÄ project. The user analysis can be implemented for an exciting product or service, which was done with Citynomadi, or for an idea of a new product or service, which was done with Tamware. Methods and steps taken in user analysis phase vary based on the product and whether the product in question is a brand new concept or existing product that is under further development. The main idea still stays the same with all products and services. Actual potential users are identified and then the user opinions and needs are gathered about relevant matters concerning the product development.

In the conceptual design phase a solution or solutions are designed that would meet the requirements set for the product and found in user analysis phase. To get more diversity in concept designs it is a good idea, if possible, to divide the design team in independent groups that each design their own solution to given problem with the same requirements. Concept is then evaluated to find best solutions for specific requirements. If there are several different concepts they can be all tested or, in a case where time and resources are limited, they can be evaluated by the team and combined to make one concept that is tested. In UCD concept is usually tested with real potential end users so to get their opinions about the solutions.

In the implementation phase the actual product is designed and built based on the concept testing results. On the piloting phase small amount of implemented products are introduced to the market to be used in real context. In the piloting phase small product problems can be still identified and fixed before launching the final product and starting mass production.

On the market phase the final product is introduced to the general public and made available. In this stage customer service is offered and feedback about the product and needs about possible improvements are gathered so that possible problems and additions to features can be designed and tested in the next iteration of the design cycle.

3.3 Observations

Observations can be a useful tool to find information about a product. It can be used to find out what works and where there is possibly need for improvements. If there is an exciting product that is under development, then observing real user interacting with exciting product can provide valuable information. If there is no products available that would fulfill the same function than the product under development it could be useful to observe products that have similar features and combine findings from those to support product development. When observing users actually using a product you can note things that would be difficult to find out just by interviewing users. Some actions the users do they might not even realize they are doing, because they may have gotten used to doing things in certain way with the product. The best result information wise is to combine observing and interviewing. So when the observer is not sure about why the user did something they did the observer can ask about it from the user.

3.4 Affinity diagram

Affinity diagrams are used to organize large sets of data logically to help support decision making. Data is organized in themes so the relevant information is easier to recognize and in this thesis with Tamware it was used to organize observations. When building an affinity diagram data is divided into small simply interpretable pieces. With a team of people who are familiar with the problem or case that data concerns the data is arranged to themes. This is done by reading each piece of data out loud so that everyone is familiar with the data and then the data is placed under the theme the general consensus of the team decides it should go under. Themes can be further placed under unifying themes that connect similar themes. Variation of this method is described in more detail under 4.2.2 Tamware Project Phases chapter in section Breakdown of Observations Data.

3.5 Concepting

Sometimes companies produce concepts of products that they consider producing. Usually when designing concept products limitations about the schedule, productions technical aspects or marketing are not limited so tightly and designers are free to design any feature they can imagine to present new innovations and possible future solutions [8]. Concepts are probably known to most at least from car shows where car companies present their concept cars with futuristic looks and accessories that some never end up

in production looking same as they are shown in the car shows. Concepts are usually used to test what features should be taken in production. Most popular features about the concept cars, features that get most interest from customers, are later applied to actual production cars.

3.6 Product evaluation with users

In UCD product development the main point is to involve actual users in testing. Evaluation of product can be done by giving users tasks to do with the product and observing how they operate to complete these tasks. Other way to evaluate the product is to interview users that have used the product about their experiences and product features. If the product doesn't exist yet the features and functions of the product can be described to potential users and their opinions gathered about the product and potential features they would prefer to have on it.

To evaluate product with user different UCD product development methods can be followed. There is for example contextual design that uses collaboration on multiple teams and divides in six steps: Contextual inquiry, work modelling, consolidation, work redesign, user environment design and prototyping [2]. Then there is participatory design where users are involved through whole design process in every step [12]. In participatory design evaluations can be made with prototypes and scenarios, evaluation workshops or evaluation walkthroughs. [12].

3.7 Wizard of Oz

Wizard of Oz is usually used for testing in early stage because it replaces the need for constructing the actual functionality behind the system. Weiss et al. [25] explains that the method allows evaluation of user experience (UX) in early stage. With the Wizard of Oz method functionality of a computer or a machine is replaced by a person that is familiar with the design. Wizard of Oz plays the role of the machine when prototypes are tested and reacts to users actions in a way the designed system would response to the same choices. This saves time and money when testing and helps to make design choices before any actual coding is done. Because the nature of the method it is suited for testing the navigation and context of the designed system rather than response times or stability.

3.8 AttrakDiff

AttrakDiff [1] is used to measure attractiveness of interactive products. Measurement is done with the help of opposite adjective pairs and some of the pairs affect different dimensions of attractiveness. Dimensions that can be evaluated with the adjective pairs

are pragmatic quality, hedonic quality – simulation, hedonic quality – identity and attractiveness. [1]

Pragmatic quality tells about the usability of a product and how well users achieve their goals using the product. Hedonic quality – stimulation describes how well the product supports people's needs to develop and move forward with it functions. Hedonic quality – identity indicates how much the product lets users to identify with it. Attractiveness describes the global value of the product based on perceived quality. Hedonic and pragmatic qualities do not affect each other and they both affect equally to the overall attractiveness of the product. [1]

4. CASE DESCRIPTIONS

In this chapter the project during which the data for this thesis was collected, and the two company cases that were involved in the project, are described in detail.

4.1 KÄPÄLÄ Project Description

KÄPÄLÄ project was a cooperation project between Tampere University of Technology (TUT) and Tampere University (UTA). Project was funded by both universities, Tredea (Tampere Region Economic Development Agency) and Tampere region ELY-Centre (Centre for Economic Development, Transport and the Environment). The project goal was to develop user experience driven service designs and bring knowledge of user experience in service design for Tampere regions small businesses. Specific focus of the project was on smart city service development.

During the project there was three workshops were companies from Tampere region were invited to attend. First workshop was the project introduction workshop which goal was to find companies to collaborate with during the project. The second workshops goal was on KÄPÄLÄ project point of view to raise awareness of the projects existent and it was held in cooperation with Technical Research Center of Finland (VTT). In the second workshop the needs of companies were mapped for the new Tampere railway station area. Workshop was divided in groups and KÄPÄLÄ project group members were present in every group making notes about the company needs. Third workshop was open for all that would like to hear how companies that have been working with KÄPÄLÄ project perceive the methods used. There were representatives from all the companies that were involved with the project telling what they learned during the process and what they gained from UCD methods.

4.2 The Goals of this Thesis Work in the Cases

With the cases described in this thesis the goal was to develop services with companies involved with potential users of their products. To get users involved in the development user centered design methods were used to plan studies and then the studies were implemented. The results of user centered development done in two cases are summarized in this thesis. This thesis goal was then to study smart city theory and find if the services designed with users are suitable for smart city concept.

4.3 Case Oy Tamware Ab

Official name of the company is Oy Tamware Ab [23] and it is a Finnish company founded in 1975. Later in this thesis the company will be just referred as Tamware. Tamware specializes in public transportations component solutions and has focused its product development in door solutions. Tamware has operations at Tampere and Maalahti in Finland. Company is export oriented and 90 percent of their products go outside Finnish borders. [23]

4.3.1 Case Introduction Tamware

Tamware had noticed that to get most out of their door solutions they have to start widening their views about the whole door usage process. Their interests are expanded from doors to include fluent traffic and transportation solutions. One key element to get the doors working as efficiently as possible is to have some kind of control over situations happening before the doors come in play. To optimize the door usage event they decided they need to develop a new kind of bus stop solution that can be used among other things to communicate information between the buses and bus stops. By having fluent information flow between the buses and the bus stop it is possible to optimize the function and flow through interface between them which is in this case the bus doors. The general idea is also that optimizing the door event the whole public transportation system can be made more efficient.

4.3.2 Tamware Project Phases

In this chapter is described the different phases of the Tamware project during KÄPÄLÄ project. Phases are described in chronological order which they were implemented.

KÄPÄLÄ Introduction Workshop

Tamware was presented by their ICT & Development Director at the first project workshop and after that he also worked through the project as the contact person for Tamware. He held a presentation describing Tamware in general and also what product they would like to work on during the cooperation with KÄPÄLÄ project.

Tamware representative explained that Tamwares target during the project would be to find out how the bus stop and general travel experience could be made better. More specifically the target would be how the bus stop event can be made more efficient and more cost effective for all stakeholders. The new product they would be developing with the aid of the project could be a new kind of bus stop that wouldn't be called a bus stop because the stop part of the term gives a feel of staying still and they would like to promote the idea on movement. Options for the new product name could be a moving

center or a hub or a launch pad thus removing the general implication that you are literally stopped while waiting for you transportation.

There are few basic main ideas behind this new Tamware product. Firstly the idea is that in the future timetables are not as important as the response times of the transportation. Secondly the advertisement space could be more efficient, faster and even targeted. Thirdly the payment transaction and fluent movement in and out of the transportation could be made better. Also data could be gathered form travelers and people using the "hubs" to better serve customer needs. With further development there could even be passenger profiles made that identify the purpose for traveling and ways to track the whole travel chain and other transportation methods.

The possible user groups for the new product were identified as people how have a bus card for local transportation, people who occasionally use public transportation and people who "never" use public transportation which includes people who only use services on special occasions. The people that "never" use bus stops could be lured to use the new hub concept by including taxi services to these new hubs on top of regular bus services.

Ideas for research of new bus stop concept were considered as finding out how regular and random bus stop users operating models differ, if you use the same bus stop every day can it be interesting and offer new experiences, what expectations people have when they arrive at new kind of bus stop.

At the end of the workshop the cooperation idea with Tamware was formed around ideating and evaluating bus stop features, designing a concept hub and testing the concept with end users during the project. This approach set Tamware between user analysis and conceptual design phases of user-centered design cycle as show in Figure 3.

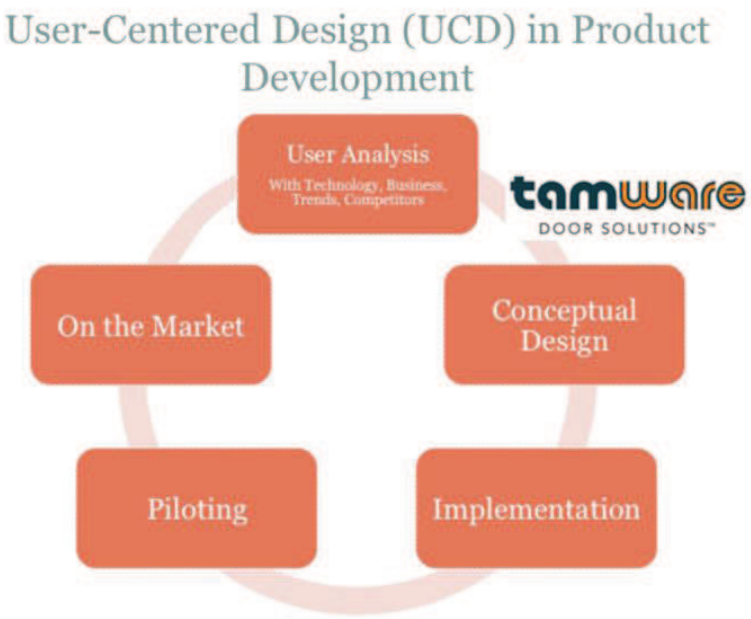

Figure 3. *Tamware case placement at the contextual design cycle*

Project Kick-Off Meeting

The first meeting with Tamware to discuss specifics of the cooperation was held in September 2014 at Tamwares Tampere office. At this first meeting the product that was going to be developed, available resources and time needed came clearer. At the end of the first meeting the outlines for the whole project were agreed and next steps for the project decided.

First thing that was considered about the project was the way it could be profitable for the company. The company needs to have some ways of making profit if it starts producing something. When considering public services like bus stops the companies that provide the bus services want to have bus stops for free and this is why there needs to be other ways to earn with this project. Decision was made to focus on using touch screens on the design because the main source for income would be in advertisement and products sold via the screens. It was also considered that the information that can be collected via the hub could be valuable. There might also be possibility to have a cut on ticket sales if it would be possible to integrate ticket system to the hub functions but this would need larger cooperation with different operators to be possible.

The screens could be divided to three sections by their usage. There could be municipal and city specific section where information about different happenings and announcements could be shown and this information would be controlled by the city. Second section could be for passengers providing them information about the schedules and arriving buses and bus routes and things like that. Third section would be for advertisements and there could also be some exchangeable module for making

advertising even more fun and captivating. The sections with the passenger and advertisements could be the ones with touch screens so that people may interact with them.

The content creating for the screens would be outsourced to other companies. Collected data from the usage of the whole hub would still be Tamwares property because it is the corner stone of the whole hub idea. Collected data will help to develop door solutions, safety solutions and with the data the whole bus stop event can be made more efficient. The idea behind making the bus stop event more efficient is than when the flow of people has been optimized the sizes of the buses can be optimized next.

The next thing that was discussed was the different directives and norms that affect bus stop design. One major limiting rule is that it is not allowed to show moving picture on a road side advertisement or at least it shouldn't be visible for the drivers. There might be a possibility to block the visibility of the screen to the streets if needed with some special lens or other solutions. There is also a list of rules designed by ELY-center just for bus stops that would probably limit the options for design choices. There is also coming in 2017 RoHS-directives for small businesses which dictate that company must be aware how much different materials are in which of their products and where the specific materials came from and that could have cost effects on the product in the future. There is an ordinance for bus stop walls also that limits the possibilities for screen placement and design. The ordinance dictates that if there is a wall at the end of the bus stop where the traffic is coming from the wall must be transparent. There are rules that set the minimum distance between the road and the bus stop but there aren't so strict rules about the width or the depth of the bus stop. But when considering from a financial point of view these rules about bus stop sizes it is probably smarter to try and limit ideas about the new product to fit the foundations of existing solutions.

For the next steps of the project it was decided that some observations should be done with existing bus stops. Finding out what new could be brought to the situation when people are waiting for a bus could be also useful. It could be also interesting to observe waiting behavior, maybe observing differences between bus and tram users could also be useful. The observation of passengers could be done from the bus stops point of view and busses could be observed from that point of view also. It was also discussed that there might be also a need to test touch screens with bus stops at some point but observations were decided for next step.

Observations of existing bus stops

Next step with Tamware was to do observations of bus stop behavior. Observations were done on four different days on five different locations. Tamware had representatives learning observation at three of these observation locations. Observations were done at the Pirkkala airport, Tampere Itsenäisyydenkatu, Tampere Hämeenkatu, Keskustori at Tampere city center and on few randomly selected busses.

The first observation was a pilot observation test at Pirkkala airport terminal. There were three KÄPÄLÄ project members present at the site and the point was to see how observing people and bus stops could be done reasonably. At the airport 4 hour observation was done about peoples actions while waiting for a bus or getting of a bus. This gave good practice for next observations. People arrived and left in clusters because of airplane schedule and it was useful to see how to divide tasks between multiple observers when there is a lot happening at once. Because of the cold and windy weather and airport terminal being right next to the bus stop there were very few people waiting outside for busses and the observations were limited mostly to people moving from busses straight inside the terminal and vice versa.

Itsenäisyydenkatu in Tampere is one of the nodes for public transportation bus changes and that is why it was selected for one of the observation locations. At the Itsenäisyydenkatu there were our Tamware contact as a representative for the company attending and learning observation. The observations were carried out so that all five observers gathered independent notes about the people and busses using different bus stops along the street. It was also agreed that if an interesting situation presents itself it would be good to also ask bus stop users some comments about the bus stops. The bus stops were observed for 3 hours in the morning until lunch break.

Hämeenkatu is the main street of Tampere and observations were focused on the north end of it where there is a railway station. Location was selected for observation because it is at the end of the main street and in the vicinity of the railway station which makes it also a node of public transportation to people going and coming from different directions. At the time of the observation there was also a big sale at a large department store located next to the observed bus stops which produced lot of people to the bus stops with shopping bags. Observations were done in the afternoon when there were also people traveling back home from work.

Keskustori is a main city square right at the center of Tampere and most of the city bus traffic stops there. It has 17 bus stops in close proximity of each other which made it ideal place to observe bus stop behavior and also people making transfers between bus lines.

Last observations were done on busses. The goal was to observe regular peoples bus behavior through the whole bus route they used and also observe bus stops from the buses point of view. During the observations it was observed how early a person shows up to wait for a bus, do people look for a schedule or some other information, what people do when they get on a bus and what they do while they are travelling. Also the whole travel time and at what point they gave the signal for the driver they are leaving the bus was observed and what do people do when exiting a bus. People were observed until it seemed that they have reached the end of their bus transit route and if some

people transferred between bus lines during the observations the observer transferred with them.

The observations focused on few key things about bus stop use and it users. The things people do while they wait for their bus was one thing. Other thing observed was do people search information from the bus stop and if they do from where and what kind of information. Also the way people move in and out of the buses were observed and the time it took to do these bus stop transactions. Peoples timing was also observed when they made transfers between busses and bus stops and also how early or late they arrived for their buses.

Breakdown of Observations Data

Observers broke down their observations from each day into notes. Notes were marked with the observers initials and the number of observation session so that in unclear situation the observation note could be tracked to the observer and more specific details can be added to make notes content more clear. Every note had one observation or comment on it. All together there were hundreds of notes that were grouped and arranged into categories by the research team over three days. The first day was spent arranging the notes near similar other notes on the wall forming clusters of observations with similarities and then general group description notes were added to clusters that described the rough similarity aspects of each group. This phase can be seen in Figure 4.

Figure 4. *Part of the observation notes grouped near each other on the first day*

Second day was spent forming smaller groups from similar observation notes arranging them so that one group of notes could be listed under more specific same theme or idea. Unifying idea or theme was written on a blue post-it-note and the observations linked to it were grouped under the post-it-note on the wall. In the situation were the number of

observation notes under one idea post-it exceeded 10-15 notes the unifying idea post-it-note was revisited for consideration. If the unifying idea could be divided into smaller more specific ideas or themes group was divided. Similar theme and idea groups were then placed near each other so that they could be grouped under more general theme unifying them as a group. Those higher level more general theme notes were written on green post-it-notes and placed on the wall over the groups.

Third day was spent organizing higher level green category groups under more general highest level unifying themes and rearranging themes if they seemed to fit better in these newly formed higher groups than they had been previously placed. These highest level themes were written on orange post-it-notes and placed highest to the wall and under them were divided all the green and blue groups formed before. This grouping can be seen in Figure 5 and more detailed formed unifying themes can be seen in Appendix A.

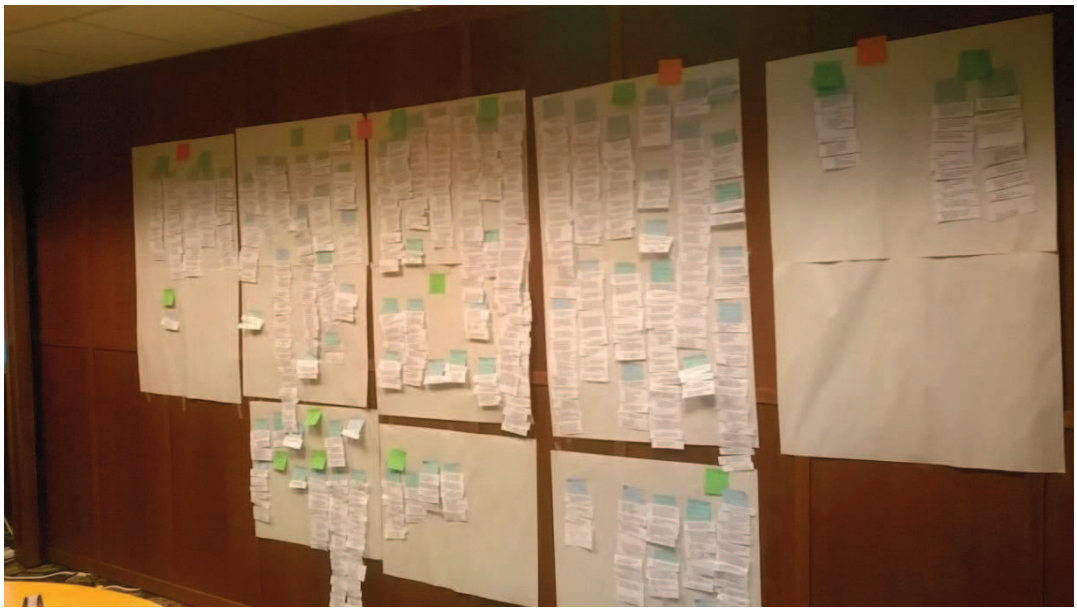

Figure 5. *Some of the grouped affinity notes under highest level themes*

After notes were grouped and the team was satisfied with the themes listed over the notes the ideations phase started. Each group member walked around and read different themes and tried to form design solutions that could satisfy the need that theme depicted. Ideas were written or drawn on post-it-notes and placed next to the group it was connected to. This method produced quickly lots of solutions to found needs and problems that groups could use to their advantage in the next phase of the case.

Concept Design and Evaluation

Project team was divided in three groups and each team would present their own design for a hub based on the refined features of the affinity wall. Groups were formed so that members from UTA designed one idea, TUT members the other and Tamware personnel the third design idea. Designed concepts can be seen from Figures 6 to 10 and

each group presented their own solution at the concept meeting. Teams described different solutions and connections that they were based on from the affinity wall findings.

Concept designed by team Tamware can be seen in Figure 6. Concept is built around one pylon that has all main functionality and bus stop can be extended around it by adding walls and roofs and screens. This pylon concept enables same basic smart services to be available at all bus stop types that are now in use from just poles that have bus numbers on it to bus stops with benches, roof and wall space. The pylon works identically from both sides so it can be used by two users at the same time and information can be seen from both directions of the road. Screen at the upper part of the pylon shows bus stops schedule information and times for next buses arrivals. It has payment point where fairs can be paid in advance and a printer that can print ticket or receipt if the user wishes so. One side of the pylon has light strip going from green to red on it and it is visible from both sides. This light strip shows how much time there is before the next bus is going to leave the bus stop so that if it is green there is still time and if it is going on red the bus is going to be leaving very soon. This gives passengers and other road users' knowledge when the bus is going to pull out of the hub. The pylon is simple to manufacture and easy to build extensions around. Places where there are more passengers and space, hubs with roof and walls with screens can be built.

Figure 6. *Tamware concept design*

Concept designed by team TUT can be seen in Figure 7. TUT concept consists of the actual hub and pylons that can added near the hub to indicate places where busses will stop in case more than one bus arrives at the same hub at the same time. The actual hub is made of two parts, curved wall that has a screen embedded in it and a roof that has a screen on top of it showing the information about arriving busses and busses that will stop at the hub. The curved wall provides shelter from wind and still leaves the side that

the bus is coming from open for view as regulations dictate. The roof goes equally over both sides of the wall giving space to seek shelter from rain and gain access to the screen wall from both sides. Screen on top of the hub will also show countdown timer that tells when the bus is going to leave the hub after it has stopped. The similar information concerning the pylons spot of the bus stop area is also give with the pylons that have screens on top of them. With the upper screens the knowledge of arriving busses and their arrival times is provided. The uncertainty about the specific place busses are stopping at is removed and also people arriving at the hub know easier if there is any need to hurry or not. Information about where passengers should wait for a specific bus line is also provided. Upper screens also help other road users with their information visibility. For example people driving cars at the road next to the hub that has a bus stopped on it get some idea about the busses intentions, is the bus going to pull out of the hub or can you drive past it safely. The inner wall of the hub is divided in three sections marked with numbers one to three in Figure 7. The first section that is marked with number one shows information customized to the specific hub. Customized information can be for example advertisements or notifications about the area. Second section marked with number two has information controlled by the city and holds the browser and advance payment features. With browser users can search routes and print out their planned routes. Third section marked with number three has information about schedules and arriving busses. Figure 8 shows TUT team hub bench design that allows users to store their bags under or next to the seats they are sitting on and still keep them off the ground. This configuration also allows people to sit by themselves without having to worry that somebody tries to sit right next to them.

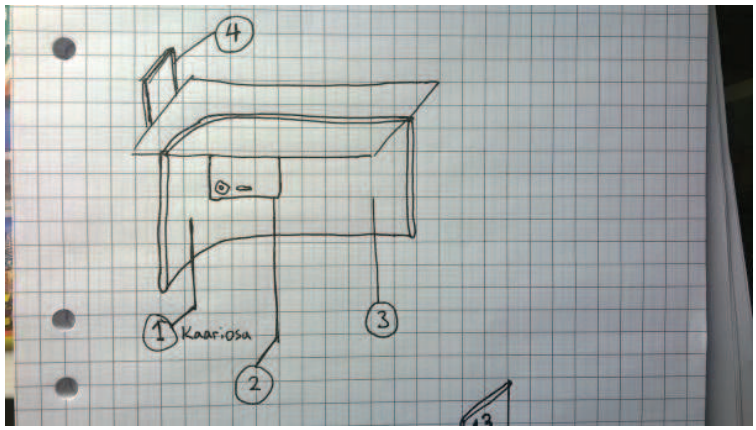

Figure 7. *TUT concept design*

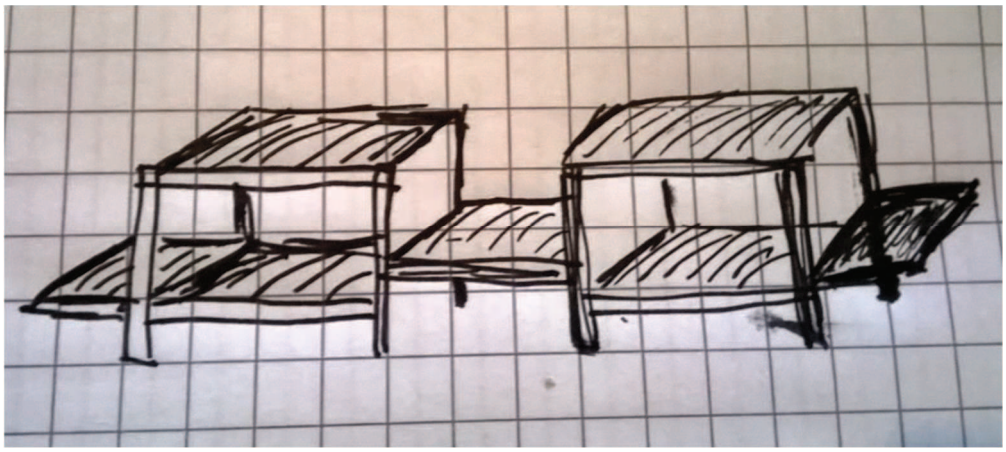

Figure 8. *TUT concept bus stop bench design*

Concept designed by team UTA can be seen in Figure 9. UTA concept was designed so that it can be fitted using same foundations that current bus stops use so it can be installed more easily and cost effectively. UTA concept has two types of screens, dynamic screens that show automated information and interactive screens that show static data but users can interact with them and then they return to basic screen mode after being inactive for predetermined amount of time. Screens are designed to be two sided so that similar kinds of screens show same information to both sides but interactive screens can still be interacted with so that they work as separate screens. Hubs can be scaled so that larger hubs have more screens and places that have no need for large hubs could only have one smaller interactive screen.

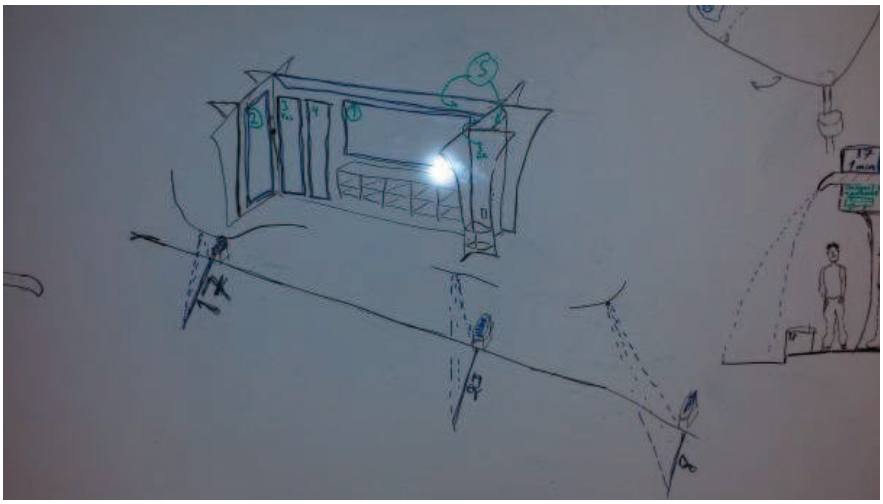

Figure 9. *UTA concept design*

In Figure 9 there are screens numbered from one to five and also three projectors that show three blue projection areas. Screen marked as number one is interactive information screen that shows in default hub information. Screen marked with number two is interactive advertisement and entertainment screen. Screens marked with number three are placed in both ends of the back wall of the hub and they show next buses leaving from the hub next to that screens end of the hub. Screen marked with number four is hubs information about the bus lines and times next busses are leaving. Screens marked with number five are near the sealing of the hub and tilted downwards. They show information about busses arrival order and how much time there is before the bus is arriving at the hub. The projectors show on the street where the specific coming bus is going to stop and what it number is. This makes queuing for specific bus more easy when there is more than one bus arriving at the hub at the same time, for example when it is rush hour and there are more buses than usual. On top of the hub there are large screens in both ends showing times for next busses arrivals and when a bus is at the bus stop they show how much time there is before the bus is leaving.

Figure 10 shows the large UTA concept from the side where there is plenty of room to wait for a bus in shelter and screens showing information about arriving busses. Large roof shelters users as near to the road as possible so that when it is raining the chance of getting wet when getting on a bus is minimized. The inner side of the hub area is heated so it brings comfort in colder season and also protects the electronics from freezing. All interactive screens have NFC (Near Field Communication) payment points next to them. These payment points can be used to pay bus fares in advance but also to buy digital goods like daily newspapers for your smart device to read on the bus. With screens it could be possible to even buy physical goods like coffee from nearby coffee shop to be delivered at the hub if there is enough time before the specific bus is arriving. Payments can be done with a bus card, smart phone payment application or with NFC readable credit card. In all the corners of the hub there are private sitting corners that have two walls giving privacy. Private corners also have payment points that can be

used to buy heating and silent moments. Silent moments are provided by producing surround noise canceling counter noise to the corner with focused speakers. Furthest corners under the roof, in Figure 10 on the right, are reserved for smokers so when it is raining smokers do not have to be in the same area with non-smokers or get wet in the rain. Hubs offer media content to users which can be freely consumed after paying the bus fare until the bus arrives at the hub. Other services provided by the hub after paying the fare are USB-ports (Universal Serial Bus) that can be used to charge mobile devices and free WLAN (Wireless Local Area Network).

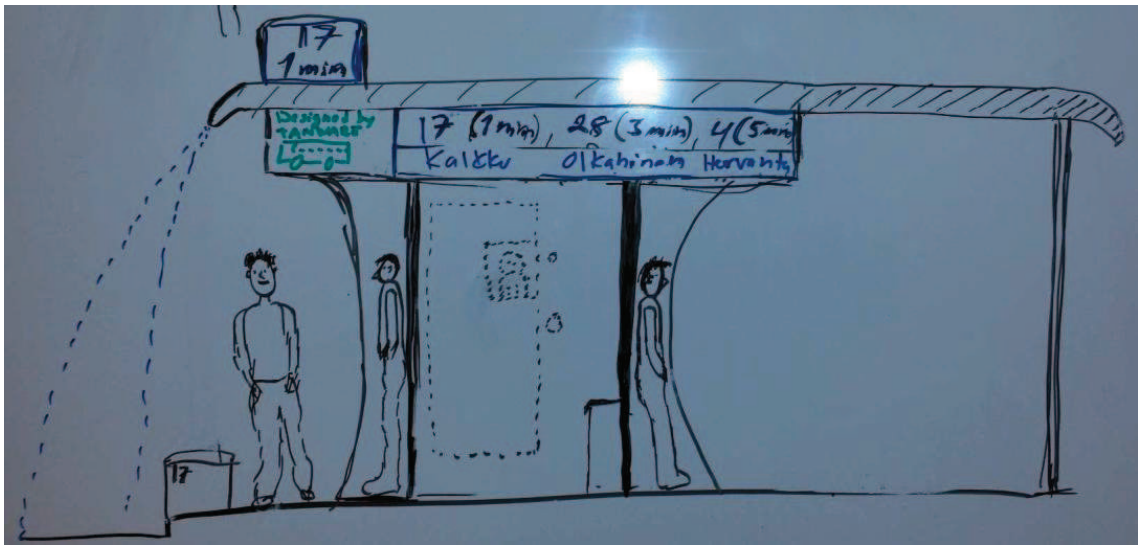

Figure 10. *UTA concept design from the side*

Based on these three concepts and affinity wall findings best features were picked by the group to be implemented in the actual prototype of a hub. The basic idea was decided to be broken down Tamware team pylon concept with an advance payment point that enables fares to be paid to busses at the Hub and two sided upper screens showing Smart Hub bus information and arriving busses. Added to the pylon functions the prototype to be built and tested would have hub structure with large interactive two sided screen on one end that provides notifications, advertisements and search options about busses and bus lines. Payment point from the pylon would be added near the interactive screen. Pylons upper screens would be mounted on top of the hub roof. Screens need internet connection so Smart Hub can also provide WLAN connection to it users. Prototype Smart Hub would also have a bench that has space underneath it where people can set down their bags so they can keep an eye on them and they do not touch the ground. The light strip indication system from Tamware would also be used in the prototype. To prevent vandalism the material used in the pylon should be tough and resistant and the Smart Hub should probably have some kind of surveillance system recording the area.

Smart Hub Prototype Evaluation Plan

Tamware was ordering a prototype Smart Hub and screens that can be fitted to the hub. It was decided that when all the parts have arrived and assembled in Tamware's warehouse we will conduct three group user studies with the Smart Hub and also include Tamware's bus doors to the test to bring more realistic feel to the tests. Doors could be used in tests to add realistic feel for arriving and leaving from the Smart Hub and they would also tie Tamware's existing products to the test more tightly.

For the prototype it was decided that we could use interactive scenarios in three sessions with five people. Test participants should be people between ages from 15 to 80 who use busses at least ones a week and own a local area bus card. Main focus for the user studies would be to test overall practicality of individual prototype features and find out end user opinions about the features individually and as a whole concept. The preliminary timetable for the tests was set at the beginning of December 2014.

List of required material, instruments and tools and testing personnel became quite extensive due to our elaborate scenario designs. There would be also a need for a space with table and seats for the attendees, space large enough for the prototype to be set up and has enough length so that previous and next bus stop mockups are visible from the prototype but not in its immediate proximity, and there should also be enough space so that bus doors can be moved around. Also wizards of Oz should be able to be placed out of sight of the test attendances. Material needed for initial test plan was designed so that at the tests there would have to be 3-5 video cameras and stands, areal microphone and recorder, 4 computers preferably laptops one for each screen, Smart Hub prototype with two sided large touch screen on one end and on screen on top of the Smart Hub, paying point for the Smart Hub and at least five cards that work with reader for test user, bus doors preferably on top of a movable platform with a screen next to the doors telling bus numbers, mockup bus stops for both sides of the prototype, few notebooks and scenario descriptions, questionnaires for participants at the beginning and at the end of the test sessions, radios for coordinating between the wizards, master wizard and interviewer. According to initial test plan there should preferably be eight person test personnel behind each test session. One master wizard of Oz that coordinates with other wizards what should be happening with their territories at each given time, two wizards of Oz that handle the touch screens, one wizard of Oz that handles the screen on top of the Smart Hub and recording of sound with the areal microphone from the Smart Hub, one wizard of Oz to handle bus doors opening and closing and changes the bus number to match other screens information, one person to help move the platform with the doors with the bus wizard of Oz, one person that is responsible for taking notes and making sure that all the cameras work, one interviewer that sets up the scenarios and gives tasks to test users. Some of these personnel tasks can be combined or eliminated if needed with few changes.

Test sessions are divided to preliminary interview and questionnaire at the begging, four test case scenarios, interview after the scenarios and end questionnaire. With first scenario the ability to pay your journey beforehand and test user reactions for focused advertisement is tested. Second scenario tests where users would search information about busses with the new prototype, do they notice the offered information and are they able to find the correct bus with the information they are given. Third scenario tests if the users are able to find the information they want with the prototype, what happens when more than one person at the time needs information about different things and do test users realize that there are multiple touch screens they can interact with at the same time. Fourth scenario tests if the users can find correct hub for busses they have been given and do users realize the simulated urgency with their buses arrivals.

Prototype Evaluation Scenarios Descriptions

The prototype evaluation had four scenarios where participants were given tasks they should try to complete with the prototype. After each task was completed the participants filled out a questionnaire where they were asked to evaluate the difficultness of the task, how they feel they succeeded with the task and how well the prototype supported their task. Each scenario questionnaire also had some scenario specific open questions.

At the first scenario participants were instructed to go to the prototype one at a time and pay the fare beforehand with the bus card mockup they were given. After paying they were instructed to stay at the Smart Hub and wait. After each payment different advertisement with increasing personalized information was shown at the screen. The reason for showing increasingly personalized advertisements was to find out where people think that appropriate line should be drawn in advertising and their personal privacy. The advertisements were about pizza offers, clothing, shops in the area the bus was heading, persons own personal cars yearly inspection time and dentist advertisement that indicated that the time for a checkup is long overdue. The first scenarios specified questions concerned feelings and thoughts about paying in advance at the Smart Hub and how the advertisements were noticed and perceived.

For the second scenario participants were given forms with different buss numbers written on them and then given a task to find out looking at the prototypes screens how much time there is before their bus arrives at the Smart Hub. The scenario based questions on this case focused on the information. Participants were asked where they found the information, what information they noticed and what other information they feel they would need at the Smart Hub.

In the third scenario participants were given different pre-set locations and were asked to find out by interacting with the prototype what bus would take them to that destination and when would it arrive at the Smart Hub. In the prototype main view on the screen was a map screenshot from popular REPA-reittiopas webpage used by many

in Tampere region to find busses and routes of local public transportation. On the screen the pre-set locations were circled and names of the places written inside the circles. At this scenario more detailed questions were about how the information was found, were there any difficulties finding the information, how more than one user affects the searching of information and what could be offered to users to make searching easier.

The fourth scenario was done by sending participants at the prototype one-by-one. They were given a bus number and a task to find out when their bus is coming at the Smart Hub, they also had to find out if the bus is leaving from previous, present or the next bus stop, and mark down if they are in a hurry or not. The timing of participants arriving at the Smart Hub was designed so that information that was changing automatically on the screens was same through each study for specific participants. The scenario specific questions were about the place where the information was found, possible difficulties of the situation and in general what kind of information the Smart Hub could offer to support people who are chancing busses.

Smart Hub Prototype Evaluation

The search for participants to the prototype evaluation was started two weeks before the tests and participants were recruited through universities mailing lists, social media profiles of project members, social media groups and other social connections.

Because the actual prototype for the Smart Hub was not finished in the time frame we had for the testing and the project the prototype was build using material and resources that were available at the time. To maximize the number of willing participant prototype was set up in the laboratory at the Tampere University because of its location near Tampere city central was determined to be more easily accessible for people than Tampere University of Technology or Tamware offices which both are located further form the city center.

The chosen laboratory at UTA had projectors that could project panoramic continuous picture to three of the four walls of the space. With the projectors there was a panoramic picture of the view from the Tampere city center bus stop projected at the walls and picture aligned with the prototype so that it depicted the actual view a person would have when looking around from that specific bus stop. Also the data that was provided in the screens during the tests was formed so it matched the actual bus lines and schedules from that specific bus stop to add realism to the test.

To describe the Smart Hub bench and mark out the back wall of the Smart Hub three chairs next to each other were used at the center of the prototype setup. Because there was limited space in the laboratory in was decided that single 15” computer display facing the prototype on top of the raised platform would be sufficient enough to play the role of two sided upper display on top of the Smart Hub. One sided display was decided to be enough because there wasn’t enough space in the laboratory to actual set the upper

screen far enough from the back wall so that the upper display could be viewed naturally at the direction that busses would be arriving from. The prototype didn't have a roof like an actual Smart Hub so the upper screen facing the Smart Hub and which usually would be viewed further away was thought to be visible enough from the prototype to be used in testing. The space in laboratory and resources also limited the prototype to have only one larger 42" display mounted horizontal and facing inwards at the estimated height for easy usage of the prototype to portray the two sided large interactive display. Number of displays at the prototype was also limited to two because we had only one wizard of Oz available for the tests and two displays connected to two laptops were decided to be the limit that one wizard could handle fluently during the testing.

Because there was no user interface ready for the prototype some of the information that could be available at the Smart Hub was presented to users via screens displaying coarse mockups views made with power point. This was decided to be sufficient way to present the data because the goal was only to present the type of information that the new concept could offer, not to test a user interface that had not been designed yet. And because the screen was not an actual touch screen the wizard was in charge of chancing the views when people interacted with it.

To record interaction done with the prototype two cameras were set up to film the prototype. One camera was focused on the larger screen that showed more information and was interacted with and the second camera filmed the overall view of the prototype and peoples actions in general at the prototype. Third camera was set up in the room where the interviews were done to catch comments and conversation for later analysis. General view of the prototype setup can be seen in Figure 11.

Figure 11. *Smart Hub prototype setup*

The actual prototype evaluation was implemented at the University of Tampere. It was divided to three stages, introduction, four scenarios with the prototype and an interview. Implementation of the evaluation was done in two rooms at the university. Introduction and interviews was done in the other room and the prototype was set up in a laboratory in the other room where scenarios were implemented with the prototype.

At the introduction phase the participants were asked for their consent to participate in the study and permission to film and record the session. They were told in general about the KÄPÄLÄ project and Tamware and how the testing of the prototype would be implemented. Then the participants were asked to move to the corridor next to the prototype where the scenarios would be implemented.

The actual testing of the prototype was done according to research plan with four scenarios with different tasks that were described to the participants and after each scenario was done the participants were asked to fill out a questionnaire connected to that specific scenario. At the first scenario the participants were sent to the prototype one by one and asked to perform payment with the bus card mockup they were provided in advanced and after paying they were instructed to wait at the Smart Hub. The scenario was implemented like described in chapter Prototype Evaluation Scenarios Descriptions and after answering the questionnaire the second scenario was described to the participants. All the scenarios were implemented by this manner of describing the scenario, providing participants with tasks chancing based on the number of participants in the test according to scenario descriptions described in chapter Prototype Evaluation Scenarios Descriptions, and filling out a questionnaire about each scenario.

After the fourth scenario participants were asked to move back to the interviewing room where they started out and the interview about their views of the prototype and overall concept of Smart Hub was done based on the interview plan that can be seen in Appendix B.

Prototype evaluation results

Altogether there were three prototype evaluation sessions implemented with participants that were between ages 24 to 53. One had two female participants, one had two male participants and one had one male and two female participants. One of the participants was in a wheelchair and it gave useful different perspective for needs of a Smart Hub because hub should be accessible for people with disabilities also.

With the prototype we were trying to find answers to questions concerning information, public transportation issues and attitudes towards paying fares in advance. Questions about information focused on information needs concerning travel, information people would like to see in general, information people would be willing to share about themselves and level of personalization acceptable in advertisement.

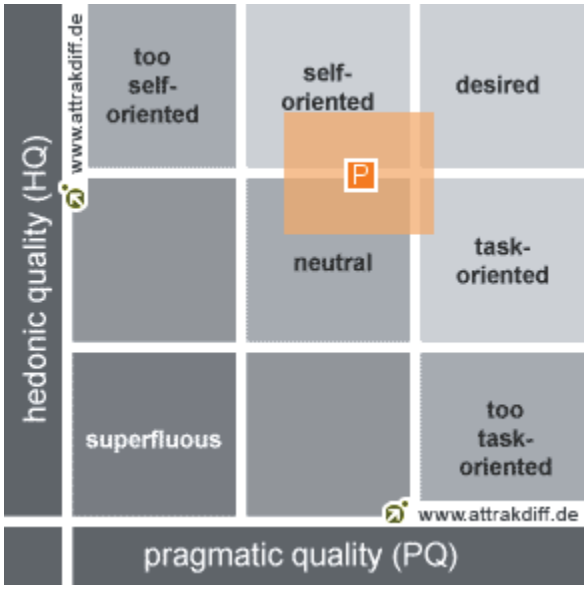

Figure 12. *Smart Hub placement on AttrakDiff Hedonic-Pragmatic scale*

AttrakDiff analysis in hedonic-pragmatic scale shown in Figure 12 shows the placement of Smart Hub analysis in general with the mark P and the larger square around it is the confidence interval. This shows that the Smart Hub is not clearly pragmatic but the user is assisted by the product. Because pragmatic quality only reaches average values there is room for improvement in terms of usability. Hedonic quality shows that users are stimulated by this product but because the confidence square overlaps equally with both areas it still can be rated average and room for improvement exists in hedonic quality also.

The confidence intervals for both scales are large and this could be contributed partly at least to limited sample size. This averageness is not a surprise although when dealing with fairly crude prototype where screens were used by wizard of Oz with just basic low fidelity information mock-up data.

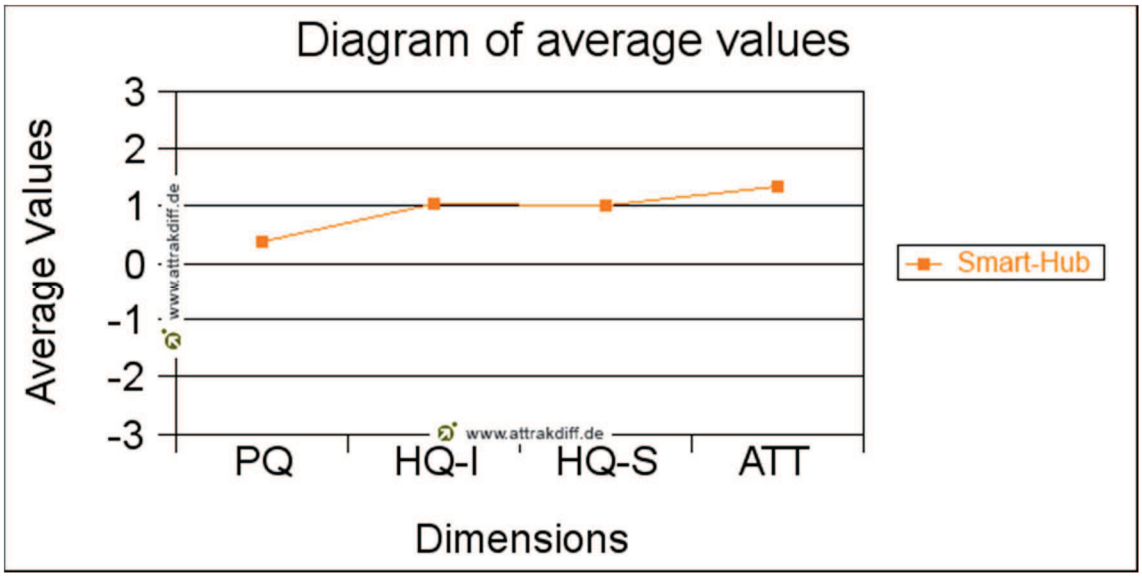

Figure 13. *Smart Hub AttrakDiff four product dimensions*

Figure 13 shows the average values of AttrakDiff. All values are on the positive side of the axis but the value of pragmatic quality is quite close to zero so there needs to be improvements done on that area. With hedonic qualities product offer users ways of identification and some stimulation but both are still at quite ordinary level and if the users are wished to be tied more strongly to the product these aspects should be improved. But as can be seen from Figure 13 although the product prototype was very crude the Smart Hub was rated above average in attractiveness so overall impression of the product is very attractive.

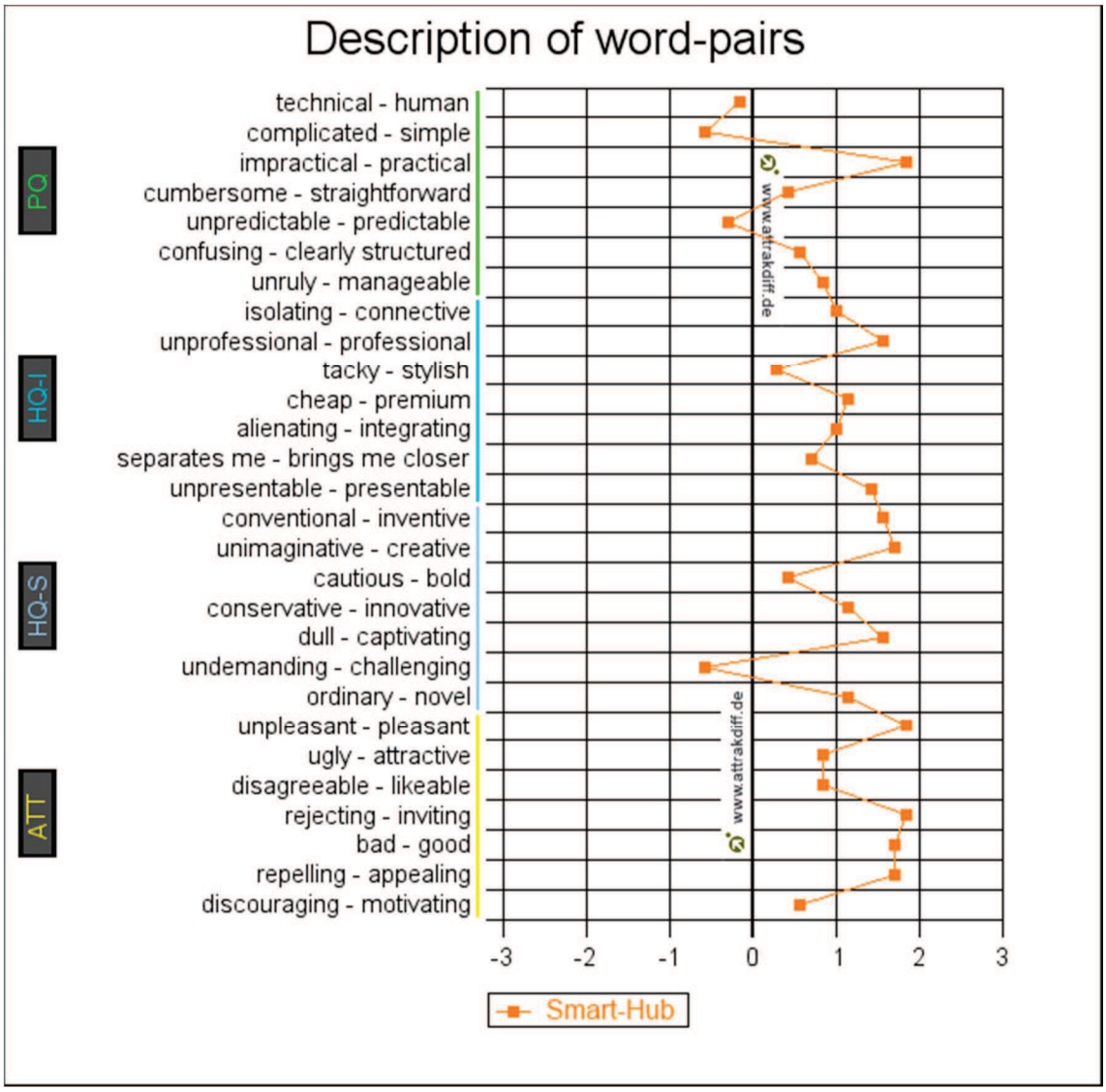

Figure 14. *Smart Hub AttrakDiff adjective word pair chart*

All the adjective word pairs and their average ratings can be seen in Figure 14. Some of the negative values in the evaluations may be traced to the use of wizard of Oz and the fact that there were no real interface designed but only crude mock-ups that were demonstrating the type of data that could be available on screens. The unpredictable and complicated values for example can be caused by the delays the screens had when operating with wizard of Oz and the few mistakes the wizard made when changing screens. On the positive side it can be seen that the Smart Hub was rated really practical. This practicality actually came up in the interviews also when one of the participants noted that this Smart Hub and it features are clearly designed for users not just novelty and presentation of new technology solutions in mind.

Numeric answers to scenario evaluation questions can be seen in Appendix D. Generally participants felt that Smart Hub supported them in their tasks little below average but they felt that they succeeded with their given tasks generally above average.

With first scenario paying in advance was thought by most to be a good idea. Only one participant said that paying in advance did not feel comfortable, but if it would make some kind of noticeable discount possible it would be alright. One participant was worried about the transfer time of one hour starting in advance and other mentioned that there should still be option to pay with cash also available. Positives sides for paying in advance that were mentions during the scenarios were easiness and the knowledge that the bus will know that it should stop at the Smart Hub and it would make getting on the bus faster. Down sides about the advance paying that were mentioned were the situation where the bus would break and would not arrive at all, the shortening of the one hour transfer time that usually starts when you get on the bus and pay the fare, the situation that your bus is late and you decide to change transportation and the feedback prototype gave about the payment was not clear enough. Four out of seven participants noticed the advertisement provided after paying but none of the participants paid much attention to them.

In the second scenario participants were asked what information they noticed at the Smart Hub about the busses. They noticed timetables of busses, arrival times, time before the bus is leaving the hub, bus numbers and destinations. When asked what other information would they like to have at the hub participants listed the following: information about the busses that are using the hub in general and where they go, current time should be visible, more clear information that tells users is the schedule times shown real time or estimates, whole day timetables for the hub, is the bus going to be late, how full is the bus.

During the scenarios participants were asked how the Smart Hub could support changing between bus-lines. Suggestions were that the hub could show how much time there is to perform the change, there could be a change to look at other busses schedules also at the Smart Hub, and ability to check how much there is transfer travel time left in a bus-card could be useful when planning transfers.

4.3.3 Smart City Service Aspects in the Case

Tamware Smart Hub concept, if implemented such as planned, would support several smart city concept features. There are connections to transportation and accessibility of the city, information sharing and betterment of information accessibility, ecology, city sensing, betterment of information quality and making communication between governance and service providers and citizens easier.

Betterment of information accessibility, sensing and making travelling more efficient are connected to following Smart Hub features. The ability to find real time information about buses loading capacities that are arriving to the Smart Hub gives users ability to plan their travelling better and removes some uncertainty about suitability of the arriving busses for people with special needs, for example people that are travelling

with strollers or with wheelchairs that only have very limited space reserved for their needs in the busses. Specific information about Smart Hubs arriving buses timetables offer users a change to plan their time usage more efficiently and knowledge about the arriving busses order removes uncertainty about specific buses arrival at the Smart Hub removing the need to constantly check and observe the road for arriving busses. Suggesting busses and transfer choices help people optimize their travel chains and time usage and at the same time make bus transportation more efficient and easier to approach and use.

The ability to pay the bus fare in advance at the Smart Hub to specific bus is connected to betterment of information, city sensing, ecology and optimization of transportation. When the user pays the bus fare to specific bus information can be gathered about the usage levels of certain busses at the specific times and the waiting time for specific user at the Smart Hub can be calculated. Based on the amount of time the user have at the Smart Hub before the bus arrives and by the bus the user has paid the fare to, focused advertisement or specific current city notifications can be provided to the user. The bus also gets the information about the user and knows that there are people coming from specific Smart Hub so there is no need for the user to monitor the road for specific bus and signal it to stop because the bus knows to stop at the Smart Hub. The bus stop event is also made more efficient because people do not need to queue for the front door and wait their turn for paying the fare because the fare is already paid and bus can be loaded from all the doors more efficiently. This has also ecological effect because busses use less time stopped at the Smart Hub, they use less time idling and they take less time to travel the route. This shorten travel time makes buses more efficient and inviting travel option and less busses are needed to do the same amount of shifts for routes. Bus sizes can be also optimized based of usage data which saves fuel and environment.

Connection to communication improvement between service providers and city and citizens was already mentioned in some level at the connections to paying the fare in advance. The screens on the Smart Hub can be used to provide information specific to Smart Hub surroundings, this information can be about services or city notifications that are specific to the area or concern everybody in the city. This system could be also used by citizens to communicate problems they notice about the Smart Hub or its surroundings to parties that the problem concern. For example if there has been vandalism to the Smart Hub or there is a pothole at the street near the Smart Hub, citizens can leave notices through the Smart Hub about the problems.

4.4 Case Citynomadi

Citynomadi [5] is a company that offers different kinds of routes for its users to go and visit through its Nomadi application for mobile devices. Users can also create their own routes and include them to the system for everyone to use. They also offer customized versions of their product to companies and cities for their own use. Different routes can

be viewed with internet browser or by mobile application. Citynomadi has had its product on the market since 2009 and it has been in constant development. Originally the idea was to offer walking routes in urban surroundings that lasted about an hour. The concept has developed since then to tours varying from themed walking tours made for different cities about their culture sights to routes created by individual users themselves about their own interests. There is also ability to make quizzes in routes or create location based polls.

Goal of the company is that people have a chance to experience something new and interact with their surroundings. Routes can be used online or they can be downloaded to mobile device for offline use. With a mobile application users can search routes near them and also create new routes. Routes can be also created by the company or individual users. One of their product types is also white label products that customers can add just their own routes in and modify it looking like their own product. Routes are fully customizable including icons, routes, points of interest and information and context used. It is possible to edit routes also with specially made tuner program and there is no need to contact Citynomadi personnel for editing, the customers can do editing by themselves. Based on the route creator the routes are divided in premium and community routes. Community routes are created by individual users and their quality varies. Citynomadi webpage does not show difference between community and premium routes at the moment.

4.4.1 Case Introduction Citynomadi

Citynomadi wanted to find ways to activate the community in route creating. They are developing a new easier tool for creating routes. Idea behind the new tool is that people can more easily create new routes by themselves and this way they can also create more content for the Citynomadi service. They currently have an application that requires installation and the new editor would be web based and there for easier to access.

They want to figure out ways to get new users interested and involved in route developing and this way also get users to adopt their service to their everyday lives. They need to know what users want from the system and what they can do to better to accommodate user need so that users would start creating their own content to the system. With new users and tools they hope to better the quality of their service and raise the awareness about their product.

4.4.2 Citynomadi Project Phases

In this chapter is described the different phases of the Citynomadi case during KÄPÄLÄ project. Phases are described in chronological order which they were implemented.

KÄPÄLÄ Introduction Workshop

Citynomadi was presented at the first workshop by their Software Engineer who presented the Citynomadi and their product and explained that they have a finished product on the market but the company is presently renewing their Nomadi application. At the time of the first workshop Citynomadi product was according to them at the phase where it could be placed between the development and analysis phase and evaluation and testing phase of the contextual design cycle.

Citynomadi was developing a route designing tools suitable for web use. They were also researching ways to utilize usage of open data with their product for future use. At the time their main development ideas for the product were to find out ways how they could offer routes to users that are not just near user location and how to combine on the concept level route content produced by professionals and basic users.

The company was aware at the time how the route generating tool is used and how much their route application is used mostly by tracking the times the applications are downloaded and used. At the time the Citynomadi recognized their user groups as being travelers, travel agents, cities agencies and people living in cities. Their user could also be divided in two by the way they use Citynomadi services. Other group is route creators that produce content for their service and other regular users who consume the content.

Citynomadi main customers were companies and organizations that used their product platform with their own customers. Example was given about city of Porvoo that uses their platform for city route in which local companies can buy visibility in the route and get their information and location added to the route. Basic use case with Citynomadi product through its customers is that user reads a pre generated QR code (Quick Response Code) and the application starts the route linked to the code for user. Other general use case is that user searches routes that are near with the application and pics the one that is interesting.

The possible cooperation with the project that Citynomadi wanted to have after the workshop was that the whole product family could be put through usability testing and iteration. There were also consideration about the need of field studies and ways to support route creation more. Because of their needs Citynomadi was placed at the user-centered design cycle between on the market and user analysis phases as shown on Figure 15.

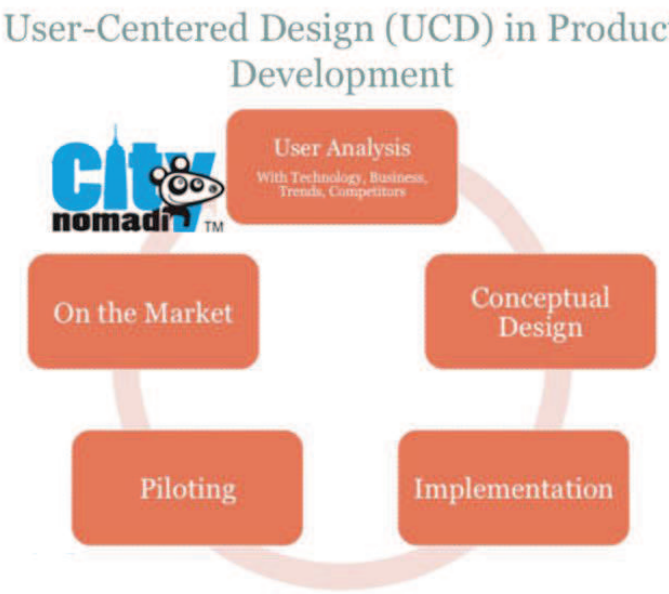

Figure 15. *The placement of Citynomadi case on the user-centered design cycle*

Project Kick-Off Meeting

The first meeting about the project cooperation details with KÄPÄLÄ and Citynomadi was held in September 2014. There was most of the Citynomadi staff present at the meeting and the goal of the meeting was to find out what were the most important aspects they felt they would need assistance in and in what time frame KÄPÄLÄ project could assist them.

It was agreed that the company was right now on two phases at the contextual design cycle. They had product on the market and they also were developing improvements to their product so they were at the user analysis stage of the cycle. Citynomadis main goal at the time was to find out how and to what direction should they improve their product. Cities would be ideal customers for city tours and different routes for tourists and citizens.

For places where there are not paying company customers to create routes for the answer for route creation could be community routes. There is just a need to get community more active and route creating more inviting and easy. At the time Citynomadi felt that they cannot provide quality routes everywhere and the quality control of community routes is limited to one day a week check when someone at the company tries to look through new routes.

Originally the route creating was planned to happen just by walking the route with your mobile device and adding all the sights and route details at the same time, but presently the routes can be created with tuner program without ever even visiting the place for real. With KÄPÄLÄ project there could be an opportunity to work on making community more aware on route making. It would be interesting to find out what would the product need to get people creating routes and using the product altogether more. It was considered that maybe users that already use the product can be interviewed about the improvements the product would need. There could also be a need to find early adopters for this kind of product. Possible user groups could be caravan owners, people who spend time outdoors doing sports or youths. Maybe getting different sports clubs involved could make route creating to pick up. If there were some kind of gaming aspect for creating and collecting and using routes that could activate the public.

The decisions of first meetings lead to conclusions that at first we could have a bit more relaxed pace. Citynomadi would need some time to finish and test their latest version of web Tuner software for creating routes. The KÄPÄLÄ team could use some time to test the product and tuner by themselves and form ideas about possible improvements.

Nomadi Application User Study Plan

To test Nomadi application a focus group user study was planned. Different potential user groups for Nomadi that could be useful for test the application with were decided to be travel guides, youths and caravan owners.

The travel guides were selected to be in the study because the Nomadi application is currently largely used to see interesting sights and learn more about them. So it basically tries to fulfill the functionality of a travel guide. This is why travel guides input for further development of the application was thought to be essential. Travel guides could also give feedback about using Nomadi as a supporting feature in their own work.

With youths the focus was to have people between 15-20 years of age in the group study. They were selected because young people usually are fast adopters of new technology and their insights for making Nomadi more inviting for young people could be useful when trying to reach new user groups.

Caravan owners were selected for the third group because they travel a lot with their caravans. Caravans also set some limits for where they can camp so they tend to stay in same designated areas for caravans when travelling. This was thought to be potential user group that could benefit from sharing their knowledge about points of interests around the camping places and they could provide interesting points of view for the use of Nomadi.

The study was planned so that at the begging of each focus group session there would be the project group and Citynomadi representative present to give short introductions. One of the group members will tell shorty about the project and then Citynomadi representative tells general description about their product to the focus group.

Participants would be asked to fill out a form with few background questions about themselves and few general questions about their knowledge and habits connected to the Citynomadi products field. Then the participants will be get tablets that have pre made test user accounts already logged in to the Nomadi application. These test user accounts also enabled that the participants can later have access to the Nomadi web tuner route editor.

With the tablets, the test users are taken outside next to the nearby park around Tampere Hall and they are instructed to create a route with their devices along the preplanned path around the hall and add some points of interest on their route with pictures. The planned route was a loop around Tampere Hall and the end point of the path was the same as the starting point. After the route creation test group moves back inside where Citynomadi representative presents and instructs the users to their web editor. Participants are told how to edit their routes and what can be done with the editor in general.

After the introduction the main interview about the Nomadi application is done. The interview questions can be seen in Appendix C. One group member will work as secretary and write down main points of the interview and one member will be the interviewer. Other group members and Citynomadi representative will move to another

room and observe the interview via computer video link. This is done so that participants would feel more relaxed and open about commenting the Nomadi application. In the interview questions regarding the user experience of the product, the possibilities they come up with for the product, their own habits regarding sharing information and planning trips, and their thoughts about the system they had just been introduced are asked.

After the main interview the participants are asked to fill out an attract diff questionnaire form about the product and their experience with it. All participants are also given their test user login information and asked to test the editor later with the routes they had just produced and answer an online questionnaire about their experience afterwards.

User Study Results

There were altogether nine participants in the study with ages between 19 and 69. Eight out of nine participants were females. First focus group had tourist guides from Tampere region. Second group that was originally planned to be youths with ages between 15 and 20 was altered so that we had three students from Tampere universities between ages 19 to 24. The third group that was planned to be caravanning people had to be changed due to recruiting difficulties to people that travel and go camping. This third focus group had two participants.

All the interview sessions were transcribed and the individual comments with similar ideas were then grouped together under main points that they were describing. These points were gathered to groups that described the general field they were connected to. This method was somewhat similar to the affinity wall grouping method used in Tamware case, but notes were in electronic form and initial grouping was done individually about different groups by different KÄPÄLÄ group members. The final grouping of all notes together was done in a group and then presented to the Citynomadi representatives.

Only one out of eight participants had heard about Citynomadi before the study and participants were asked ways to make Citynomadi more known to people. It was suggested that Citynomadi could organize campaigns where people are invited to create new routes or content to existing routes. It was also held important that Citynomadi would link it service with social media providers like facebook and twitter. This would make route sharing easier and help potential new users to find the service.

When asked about the type of content and routes study participants would like to have in Nomadi application the general opinion was that they would like to have wide range of different kind of route creating possibilities for different audiences and flexible control over limiting the sharing of their routes. To get people interest about the service it is important that they find what is useful about the service especially for them as an

individual. Participants stated that they would like to create routes for their own use. Own use could include making a travel diary with the application and then at first sharing it with limited group of friends and maybe later with wider audience. Routes created just for group of friend or acquaintances were also perceived as interesting way of using the service.

When asked for ways to make content creation more inviting to people some participants told that getting feedback from own routes or showing content that is self-created could be motivating. It was noted that when someone decides to share content that one has created it is usually important that the popularity and success of that content can be tracked. It is also important that other users can comment and give feedback about the content shared in service to create interaction between users.

Study participants liked Citynomadi service and it got from the participants average grade of 8 out of scale from 1 to 10. Study participants attitudes towards technology, attitudes towards different possibilities for service usage and answers to statements concerning connectedness, collaboration, enjoyment, self-expression, discovery and audience and privacy can be seen in Appendix D.

From Figure 16 can be seen that in AttrakDiff questionnaire participants placed Citynomadi in desired section on hedonic-pragmatic scale.

Figure 16. *Citynomadi placement on AttrakDiff Hedonic-Pragmatic scale*

With Figure 17 can be seen that Citynomadi was scaled on the positive side of the axis on all fields of evaluation. Improvements can be made on the fields of stimulation and identity which determine how the product supports user identity and stimulates and challenges user. The pragmatic section that determines the practicality of the product was second best graded and highest score Citynomadi got from attractiveness which determines pleasantness and desirability of the product.

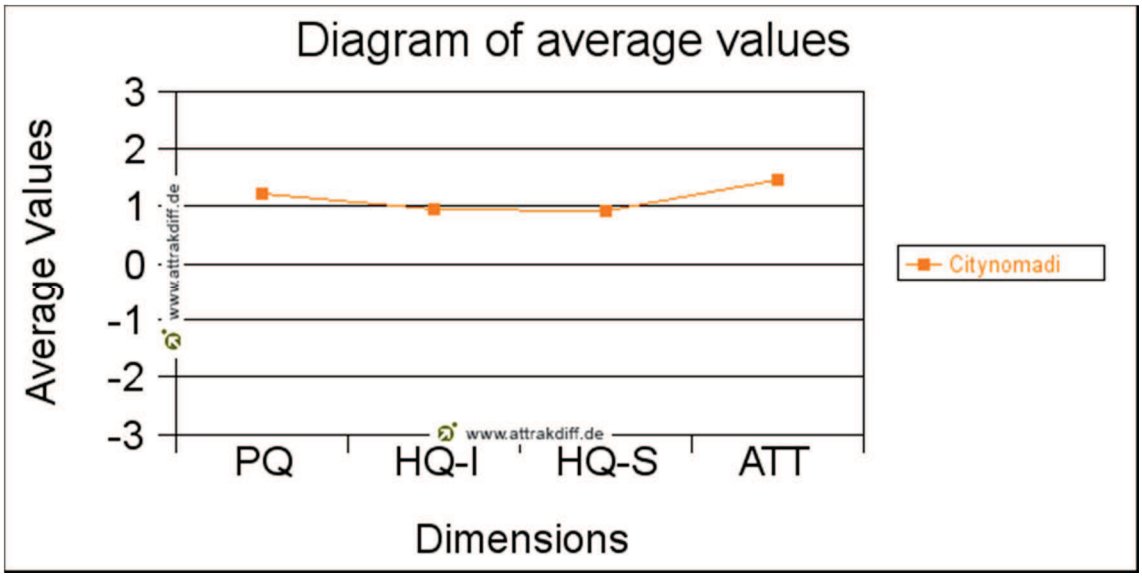

Figure 17. *Citynomadi AttrakDiff four product dimensions*

In Figure 18 AttrakDiff word pairing for Citynomadi can be seen and it shows that all but one word pair was ranked on the positive side of the scale. And the one word pair that was scaled on the negative side is undemanding – challenging that can be also interpreted as a positive thing in the case on Citynomadi. Especially good grades Citynomadi got from presentable, innovative and inviting elements.

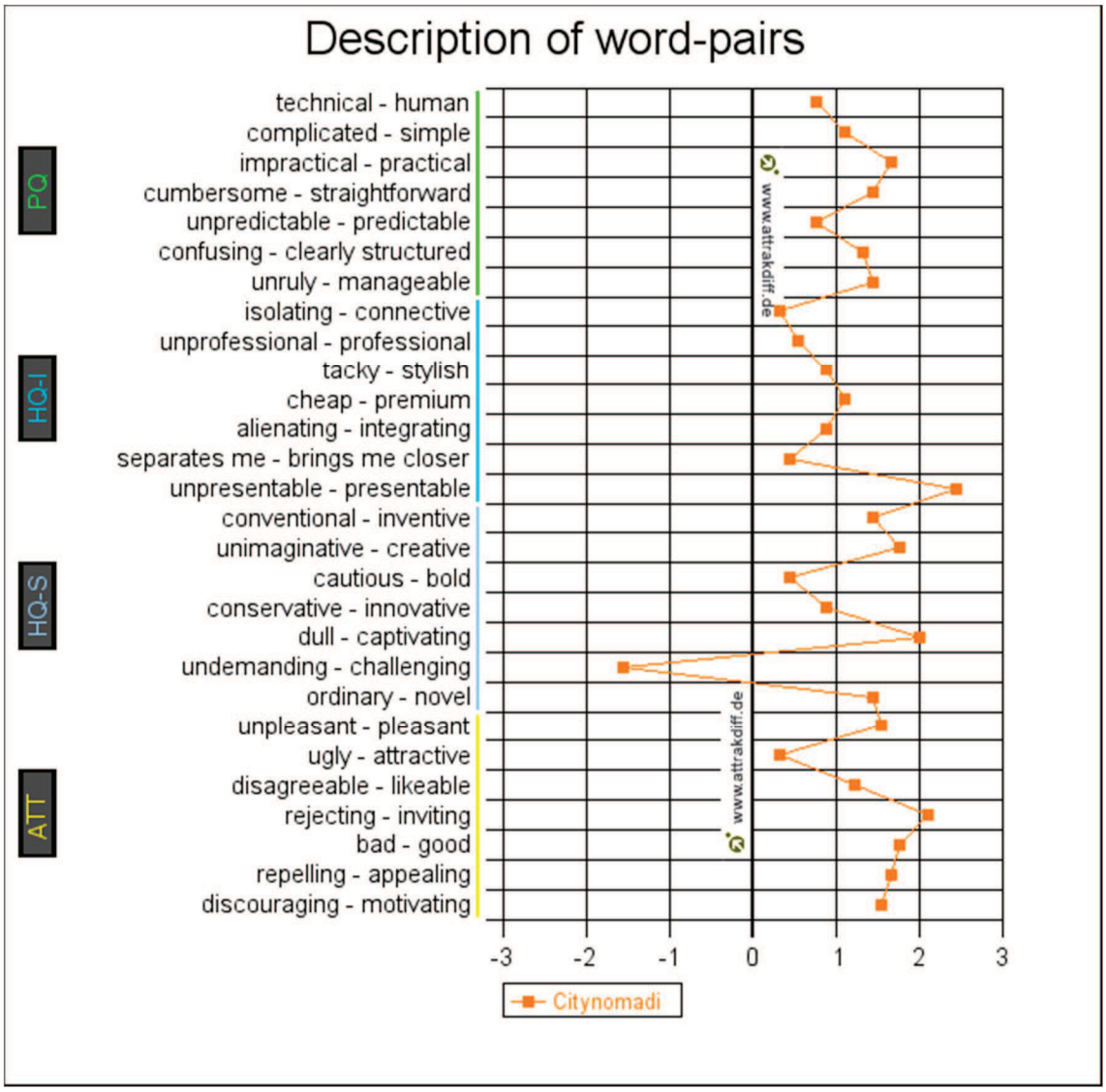

Figure 18. *Citynomadi AttrakDiff adjective word pair chart*

4.4.3 Smart City Service Aspects in Citynomadi Case

With Nomadi application there is good potential to improve the smartness of city with the current version of their application and the potential is even greater if they decide to implement new features and functions recognized for their service during the KÄPÄLÄ project. The application supports at least the following smart city properties: communality, knowledge sharing, context aware city sensing, tourism, communication between decision makers and citizens, ecology and accessibility of the city.

The application can be used to share knowledge via routes about areas or services available in the city by people how now more about them to people who are not so familiar with them. This information can be almost anything imaginable; it can vary from the history of the places to interesting shortcuts in the area to coffee shops that provide good coffee. This knowledge sharing has also communality aspect that gives

users ability to rate and comment routes so good routes can be recognized by other users. If some routes are classified communal to give users a change to add their own knowledge and points to the routes, or add alternative route options on top of existing routes if they feel something important is missing from them, this makes communality and knowledge sharing even more effective.

When these routes are used to share knowledge about the city and best route options to take in different situations they make the accessibility of the city better, more ecological and more inviting to tourist. The application also makes citizens active city sensors, they provide their knowledge and feedback to routes and provide valuable information about the city, but they can also provide their opinions to different polls set by the city decision makers. With the location aware application city can provide polls about the area the user is in and via different types of media options show users for example different visions about the area development plans made. Citizens can move around the area that city is going to develop and look through different suggestions about possible development choices and vote the one that they like the most.

5. EVALUATION OF THE CASES BY THE COMPANY REPRESENTATIVES

This chapter describes how companies evaluated their participation in the KÄPÄLÄ project. For the final workshop of the KÄPÄLÄ project companies involved were asked to prepare short presentation about their participation in the project. Companies were asked to describe how they felt about the methods used and did they receive or learn anything that they perceive useful for them at the time and possibly for the future.

5.1 Case Evaluation Tamware

With Tamware the identification of their placement in UCD product development cycle was successful and the project team was able to assist Tamware with designing a concept for their specific product need. The work was done according to UCD methods and prototype testing with end users gave positive feedback about possible implementable features to the product.

In the third workshop Tamware's presentative expressed that they have learned new and useful things during the case and the UCD product development is valuable method for designing products. Tamware had also already started sharing the knowledge learned during the case with others in the company who did not participate in the case at the time.

At the start the case was on schedule very well and overall useful information was gathered. The only delay in schedule came with the final stage of the case when the prototype was supposed to be evaluated. Prototype evaluation had to be postponed couple of times and finally do to time issues implemented without an actual prototype due to part delivery delays. Although the testing was done with more crude prototype than originally planned the test produced good data about the features for the product.

Smart Hub needs to be tested again with finished prototype and larger user group to get more accurate data and better understanding of its potential. Testing should also have more finished prototype of the user interface so its use and content can be evaluated in the context of the whole Smart Hub. User interface can and should be tested independently from the Smart Hub when designing it, but to get most out of the whole Smart Hub user testing at least general navigation and information layout should be presented and tested with the users same time with the Smart Hub prototype.

5.2 Case Evaluation Citynomadi

Citynomadi representative told in the third workshop that they have found UCD methods useful and they have also already tried some methods they have heard used with other participants in the project. During the project Citynomadi was able to get user analysis about their exciting product and also received good design ideas for the next development cycle of their product.

With Citynomadi the schedule was designed to be flexible and all the designed work was completed when the company and KÄPÄLÄ project team were able to fit their schedules together during the project. With company like Citynomadi where there are only few employees the ability to find time, for so called extra work with UCD, needed flexibility and work was done when the company could free one of its employees to participate in the project.

Finding new design solutions for their product suitable for smart city context and getting feedback from potential users was successful with Citynomadi. They got information about potential new design choices for their product and feedback about their new web tuner editing platform.

All in all the Citynomadi case was completed successfully and knowledge of UCD product development methods were passed on to the company.

5.3 Overall Evaluation of the Process

Overall the process was successful. The companies involved learned the UCD methods and got insight about how valuable end user feedback can be when developing a product. With small companies with limited resources schedules have to be flexible because there are not always resources to assign one employee whole time to do work that has not been estimated to be included in the job description. Also with smaller companies resources usable may vary quickly depending on market fluctuations, order workload and project schedules.

Recruiting participants was harder than expected for these cases user studies. Recruiting should be done more flexibly or new channels to spread recruiting invitations should be found to get more participants. Other possible way that could have lured more participants to studies could have been to offer better incentives for participating, but we did not have a large budget to do so in these cases.

Both cases produced good feedback about the products but the low amount of participants in both cases user studies leave the overall large scale results open. With so small number of users with not too different backgrounds overall acceptance of the products and their features is not necessarily reliable. Also average results with small

number of participants tend to have large error tolerance because the amount of data is not sufficient to get general specific averages.

Both cases user studies however had some varying with their participants so to give wide range on glimpses to different viewpoints and varying scale opinions that can be studied and learned from. And if with this small amount of participants there were consensus visible about some features they can be said to be at least pointing in the right direction.

6. DISCUSSION AND CONCLUSIONS

In this chapter conclusions made during this thesis are summarized and aspects that need further study are opened for discussion. Goal of this thesis was to study what aspects are connected to smart cities in literature and how two services connected to KÄPÄLÄ project are suited for smart cities. With both services studied in this theses there are great potential for becoming smart city services.

6.1 Discussion

Both cases provided service solutions that supported smart city concept. During the literary review I did not find studies done about similar services that would have been focusing on the smart city service concept. I claim that both cases presented in this thesis provide new information about possible new services that can be used to make city smarter.

Both services have features that are studied and recognized to be features suitable for smart city concept. There have not been user studies made with similar services in a smart city concept before so the results from these user studies provide new insight to smart city service development. Results from the user studies also indicate what type of services people would prefer to have from the kind of services studied in these cases.

The results from user studies presented in this thesis are produced from quite small amount of participants. The amount of participants and the fact that the participants were gathered from geographically very limited area gives reason to note that these results may not be universally valid. There are results in these studies that show clear indication what the general opinion might be, but to get definite results the studies should be made with larger and more diverse group of participants.

I believe that the small number of participants is partly the result of time and resource limitation and partly the result of recruiting channels used. If more time and effort would have been used in reaching as large amount of people as possible the amount of participants would have been larger in both user studies. To make the results more reliable and sample size larger and more diverse there could have been other means for gathering data also used. These other means would have needed extra resources and more time but they would have given more valid results.

Web based questionnaires could have been made based on the study results from both studies. Questions could have been focused on the service features that were recognized

during the user studies. These questionnaires could have been distributed via different forums, mailing lists and social media pages to reach wider range of opinions and participants. Results from questionnaires would have given more information about the validity of the user study results.

6.2 Conclusions

With both cases in this thesis user-centred design methods provided good tools for making services that could be applied in smart city concept. Both cases studied have many potential connections to current smart city concept defining features which make them both potential smart city services. My conclusion about these services is that either one of them integrated successfully to any city, trying to be defined as smart, would raise the city smartness classification. These services would also make communication between city decision makers and citizens better and help improve the quality of life in the city they are integrated in.

Working with smaller companies, the schedule must be flexible and workload divided according to the resources that are available. Schedules can also be subject to change because of third party suppliers and this can lead for need to rethink the approach previously planned quite drastically. Delays in the process should be considered in advance so that the final point in schedule for changing a plan, so that it can still be implemented, can be recognized. Recognizing potential user groups for products is easier than recruiting them in studies so recruitment should start in good time before the studies with users are scheduled to be implemented.

Both companies should continue to use UCD product development methods to produce and finalize the products that have been worked on during the KÄPÄLÄ project so they can get full benefits for themselves from this short cooperation.

6.3 Future Work

To get concrete results about Smart Hub it should be tested again with more finished prototype. This prototype should also preferably have functionally quite finished interface for its touchscreens so navigation can be tested. The Smart Hub should then be placed in real context it is designed to be used in and further tests made with it in real daily use before it is but in mass production.

Citynomadi has good product which has lots of potential to serve people with adding wider range of functions. Citynomadi should study more about possible development directions that were found in studies with their product. A study with larger amount of participants can give clearer image about the functions real preference with users. When designing new features they should also be stressed according to business model and direction the company wants to take with their product.

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APPENDIX A: TAMWARE AFFINITY DIAGRAM FINDINGS

Highest level thought	Unifying thought	Thoughts and ideas
I arrive at the bus stop to leave	I hurry to my bus	I hurry to the bus stop because I think I am going to be late but I hurried unnecessarily
		I change busses running
		I miss the bus
		I run but catch the bus
		I arrive at the bus stop at the last moment
	I change to other side of the street	I change to different buses bus stop to wait
		I run across the street illegally with out using crosswalk when changing to a bus stop on the other side of the street
	I come early at the bus stop	I arrive at the bus stop in good time before hand
I search or need information for my journey	I am trying to figure out a right bus for my self and where it is leaving	I am uncertain about the right bus stop
		I check the bus stops busses
		I am uncertain about the route of the bus
	I am trying to figure out when my bus is leaving form the bus stop	I use the paper bus schedule at the bus stop
		I use the digital bus schedule
		I use my own bus schedule
		I use more than one bus schedule
		I ask information from others
What do I do when waiting at the bus stop	I can use the waiting time for my advantage	I talk while I wait
		I fix my hair at the bus stop
		I read magazine/book at the bus stop
		I listen to music while waiting a bus
		I take care of things with my phone
		I visit nearby shops while waiting
	I use my own mobile phone while waiting	I kill time with my mobile phone
		I use my mobile phone already when arriving at the bus stop
		I glance something from my mobile phone
		I am with someone and I still fiddle with my mobile phone
	There is nothing to do while waiting a bus or I do not do anything	I wait and monitor the traffic
		Children have nothing to do
		I do not need any information I just wait
		I stand and be quiet at the bus stop
		I sit at the bench while waiting
	I invent something to do for my self while waiting	I look at the advertisements or notices when I have to wait
		I walk around in the vicinity of the bus stop to kill time
		I smoke while waiting a bus
How do I look after my things at the bus stop	I trust other passengers at the bus stop	I dare to leave my bag unattended
	I protect my belongings while I am at the bus stop	I use my own bag as a bench and sit on it
	I do not want my belongings to get dirty	I use the bench to put my belongings on
Comfort at the bus stop	I affect others comfort at the bus stop with my own actions	Discomfort (rain) affects how I take others in consideration
		I don't care about other bus stop users
		I take others in consideration
	I need space while waiting	I wait outside the bus stop area
		I need my own space
		I seek shelter from rain also in the vicinity of the bus stop
	Bus stop protects me from the weather	I seek cover from rain or wind from the bus stop

Highest level thought	Unifying thought	Thoughts and ideas
We also use bus stop for other things than traveling by bus	Bus stop works as a meeting place	I also to get into passenger car from bus stop
		We meet in the vicinity of the bus stop
	Other vehicles use the bus stop also	There is also space for taxis and delivery trucks near bus stops
	Bus stop is a place to spend time or I do things at the bus stop	I am not going to travel by bus but I use the bus stop anyway
		I spend my time in the vicinity of a bus stop but continue without getting on a bus
Bus stop is not designed for me	I do not know how long it is for my bus to arrive	I don't see the bus coming
		I stand facing the direction bus is coming from
	I do not use all the features at the bus stop	At the bus stop and at the bus there are features I do not make use of
	Schedule information are not helping me	I do not get the information I need
		Some information I need is missing
		Information is contradictory
		There is too much information
	There is information or instructions missing from the bus stop	I do not know where I can get a ticket
		Schedules are not were they are supposed to be
		I do not understand the idea of info screen functions
		I can not see or find the schedule
	Bus does not go when I would like it to go	I do not want to waste my time at the bus stop
My journey is beginning at the bus stop	I signal the bus driver about my intentions to travel	We all signal the bus driver so that the bus stops
		I signal the bus driver late
		I show the bus driver that I am not going to get on
	One has to get ready for buses arrival	When the bus is coming I stop what I am doing
		I get money ready
		I take out my bus card
	How do we get on the bus	I get on the bus immediately even if it means I would have to wait before it leaves again
		We board the bus in certain order
		I pack together with others to get on the bus
		I will get on the bus - no I won't
	I choose the best way for my self to travel	What bus?
		Walk or take a bus
		By taxi, car or bus?
Getting on a bus is sometimes difficult	Buses arrival at the bus stop is not precise	I am not sure in what spot the bus is going to stop
		Where is the door going to stop?
		Bus stops somewhere else than in front of the bus stop
		Multiple busses at the same time to the bus stop - which one do I get on
	Getting on a bus is slow	Large amount of people slows down getting on the bus
		Payment problems slowdown getting on the bus
	I am not noticed as a passenger	Driver does not notice a passenger
		I did not get on the bus I wanted to get on
	Sometimes getting on a bus is easy	Bus driver is not servicing me
		We get on the bus smoothly by our selves

Highest level thought	Unifying thought	Thoughts and ideas
I can do other things while traveling on a bus	I am social on the bus	I make calls or answer to them on the bus
		I message with my mobile phone using text messages or chat
		I talk with other person on the bus
		I talk with the driver
		I show pictures from my phone to the person sitting next to me on the bus
	I entertain my self on the bus	I continue doing the same thing that I started at the bus stop
		I use my mobile phone to consume media
		I look at the traffic or scenery
		I read on the bus
		I do not do anything on the bus
		I spend time fiddleing with my mobile phone
	How am I while traveling on the bus	I go where there is free space when the bus is almost full
		I use the seat next to me to hold my bags
		I go to specific place to sit on the bus
	I make use of the time I am traveling on a bus	I eat or drink on the bus
		I care for my beauty on the bus
		I read information of the internet on my mobile phone
	Children need my attentions while traveling on a bus	Having children along affects where I sit on the bus
		I teach children how to use the bus
		For children the bus ride is different
My journey is ending	My bus stop is nearing - what do I do	I rise from my seat when the bus starts moving from previous bus stop
		I get ready for leaving the bus
		I stop what I am doing when my bus stop is getting close
		I rise from my seat only when the bus stops at my bus stop
		I also exit the bus from front doors
		I move closer to the door good time in advance
		I press the stop button good time before the bus reaches my bus stop
	I use the bus stop also after the journey	I stay at the bus stop for a while after getting off from the bus
		After the journey the bus stop is not really relevant
		I go home
		When I get off from the bus I continue my journey by foot
		I am going to a place near the bus stop
		I am going to go run some errands
	I continue my travel with other transportation	I change transportation
		I change straight to another bus

APPENDIX B: TAMWARE INTERVIEW QUESTIONS

Background information (Look at the answer forms and ask more details if needed)

1. How often do you presently use local bus services?
2. What kind of trips you take on busses?
3. What problems you presently see with bus schedules and information searching?

Route information

4. Do you search information about busses/schedules/routes before going to the bus stop? How?
5. Is there some information that you look for at the bus stop? How?
6. Is there something that could be improved concerning information searching?

Paying

Idea: Trip could be paid in advance at the bus stop and at the same time information about the arriving bus could be seen. For example information about available seats and stroller places. When paying the information is also relayed to the bus so it knows that it needs to stop at the specific bus stop and there is no need to signal to the bus to stop. After paying the bus can be loaded also through the center- and back doors.

7. Do you think that paying in advance at the bus stop could be useful?
8. Are there any problems or disadvantages that you could get from paying in advance at the bus stop?
9. Could paying in advance at the bus stop make the travel experience more efficient or better?

Information at the bus stop, advertisements and content

10. What kind of content and information would be interesting to you at the bus stop?
11. What is your opinion about advertisements at the bus stops?
12. How focused (personal/regional/other) advertisements would you like to see at the bus stop?

Communal use, history about own trips, user profile

13. Would you be interested in seeing your own travel history? What could be interesting about it?
14. Would you be interested at seeing summary about all the trips made with local public transportation?
15. What information about the routes would be important to you?

16. Would you be interested to see other public transportation users detailed anonymous trip information, from which no specific person could be identified?
17. Could you share information about your own trips with a community? How detailed information?

Smart Hub concept, passenger comfort and efficiency

18. How Smart Hub could increase passenger comfort?
19. How Smart Hub could increase travel efficiency?
20. What thoughts adding intelligence to public transportation services raises?
21. What new features could Smart Hub have?
22. What threats or problems you can see with Smart Hub?

APPENDIX C: CITYNOMADI INTERVIEW QUESTIONS

Route editing (web-tuner)

1. How did route editing feel?
2. Problems with the route editing?
3. How about writing introduction texts to points?
4. Breakdown of targets to different layers
5. Adding media: video, pictures and icons

Interview:

Background information (look at the forms and ask more if needed)

6. Do you have a smart phone? If so what model it is and what operating system it has?
7. Have you added applications to your smart device?
8. Is Citynomadi known to you from before?

Using map services in general

9. Have you made route/travel stories about your trips/holidays or written a blog about them?
10. When you are going on a trip do you search information about places beforehand? If yes then what kind of information you search and from where?
11. Do you share pictures or stories in real time through some social media service while you travel?
12. Do you share pictures or stories about trips after the trip on the net? To whom and how?
13. For what kind of purposes have you used map services? What services have you used?

Route creation, Nomadi

14. How did creating a route with Nomadi feel?
15. Were there problems with creating routes?
16. In what environment would route creating be interesting to do?
17. How could the route creating tool serve your group?
18. Free comment concerning route creation, would you do something differently; was there something that specially stuck in your mind? Are there any development or improvement ideas?

Using Nomadi

19. How would you use Nomadi?

20. What new features can you invent for Nomadi? What is missing from Nomadi?
21. What kind of competitions or campaigns would motivate people to produce content to Nomadi?
22. In what kind of situations would you use Nomadi mobile application?
23. Is route creating motivating?
24. Would you use Citynomadi more preferably with internet browser or with mobile device?
25. Would you rather create routes with browser or with mobile device?

Information and content at the location (for example at Näsinneula)

26. What kind of content about the targets would be most interesting to you at the location of the point?
27. What would be most preferable way of getting information about the targets with mobile device (audio/video/picture/text)? What about when using browser?
28. Could Citynomadi offer extra information or extra description about the target? (describing text, expanding or optional picture about the target at a different time, contrast picture for example at night or day time)

Creating content and motivations in Nomadi community

29. What could make creating routes more motivating?
30. Is it important to you that the routes are presenting your selves?
31. Is it important that others know that routes are created especially by you?
32. Is it important that your routes benefit others?
33. Do you want to know who is looking and using your routes?

Citynomadi communality

34. Are routes created by others interesting?
35. What information about routes would be important to you?
36. Should it be possible to edit routes as a community also?
37. Should it be possible to add pictures to routes created by others?
38. Should routes be private or public? Should others have ability to edit routes?

Further development ideas for Nomadi

39. Would new kind of features be interesting?
    a. Voice navigation on routes
    b. augmented reality features
40. Free comment in general about Citynomadi service if something was left unsaid or something was not asked that you think should have been asked.

APPENDIX D: CITYNOMADI STUDY NUMERIC ANSWERS

Answer to following statements concerning your attitudes and habits towards technology. (1=Completely disagree, 7= Completely agree)

	1	2	3	4	5	6	7	Total	Average
Technology is useful in my life (technology=electronic devices, like phones, cameras, tablets, computers and other similar devices)	0	0	0	1	0	4	3	8	**6.13**
Technology makes my life enjoyable	0	0	1	1	2	2	2	8	5.38
I use several mobile services (example navigation, internet, social media)	0	1	0	0	4	0	3	8	5.38
I consider myself as an skilled technology user	1	0	0	1	3	2	1	8	4.88
I create and share content publicly on the internet	2	1	1	0	3	1	0	8	3.5
I browse content other users have created on the internet	0	2	1	0	1	3	1	8	4.63
I consider myself as an social person	0	0	0	0	3	3	2	8	5.88
I am open towards content sharing	0	0	2	2	3	1	0	8	4.38
I am concerned about my privacy on the internet	0	0	0	2	2	2	2	8	5.5
Total	3	4	5	7	21	18	14	72	5.07

Participants' attitudes toward technology

How useful you think that the service is for the following purposes. (1= Not at all useful, 5= really useful)

	1= Not at all useful	2	3	4	5= really useful	Total	Average
Content creation	0	0	1	4	3	8	**4.25**
Content sharing	0	1	1	5	1	8	3.75
Finding content other users have created	0	0	1	6	1	8	**4**
Content consuming	0	0	2	5	1	8	3.88
Content enrichment (Own or others content re-sharing, content editing or remixing, content editing in collaboration)	0	1	3	4	0	8	3.38
Following own shared content	1	1	2	3	0	7	3
Total	1	3	10	27	6	47	3.71

Participants' attitudes towards different usage purposes for the service

Answer the following statements on a scale 1-7 (1= Completely disagree, 7 = Completely agree)

	1	2	3	4	5	6	7	Total	Average
It is important that I can answer and react on content created by others	0	1	0	2	3	1	1	8	4.75
It is important that others can answer and react to content I have created	0	1	0	0	4	2	1	8	**5.13**
It is important that I can see who else is present at the service	1	1	3	0	2	1	0	8	3.5
It is important to see what others are doing in the service	2	0	1	3	0	1	0	7	3.29
I am interest at seeing who has created the content I am consuming in the service	0	3	0	1	1	3	0	8	4.13
I can tell stories to other users via the service	0	0	1	1	1	3	2	8	**5.5**
This service makes content sharing to people I want easy	0	0	1	1	3	3	0	8	**5**
With the aid of the service I can get information about other service users	0	0	2	2	4	0	0	8	4.25
Service supports interaction with other users	0	0	1	1	5	1	0	8	4.75
With the aid of the service I get enough information about other users	0	1	0	1	5	1	0	8	4.63
Total	3	7	9	12	28	16	4	79	4.49

Participants answers to statements concerning the field connectedness

Answer the following statements on a scale 1-7 (1= Completely disagree, 7 = Completely agree)

	1	**2**	**3**	**4**	**5**	**6**	**7**	**Total**	**Average**
It is important that I can compare myself to other users in the service	2	1	0	1	2	2	0	8	3.75
I would allow other users to make use of the content I have created to create new content (remixing, combined content, collaboration)	1	0	1	3	1	0	2	8	4.38
I am interested about getting feedback from others about my contents	1	1	1	2	1	0	2	8	4.13
It is important that I can enrich, refine or edit content of others	1	3	1	1	1	0	1	8	3.25
It is important that users can create content together in the service	0	0	1	2	1	3	1	8	**5.13**
It is important that I can attend with my own content in offering new information to service community	0	1	0	2	2	2	1	8	4.88
I can compare myself to other users in the service	1	1	1	3	1	1	0	8	3.63
I can get feedback in the service to my content	1	1	0	3	2	0	1	8	4
My own content can get richer with the aid of other users and collaboration	0	0	2	0	3	1	2	8	**5.13**
I can produce content in the service in collaboration with other users	0	0	0	2	3	2	0	7	**5**
I feel that I can give something new to the community of the service	1	0	0	2	2	2	1	8	4.75
Total	8	8	7	21	19	13	11	87	4.36

Participants answers to statements concerning the field collaboration

Answer the following statements on a scale 1-7 (1= Completely disagree, 7 = Completely agree)

	1	2	3	4	5	6	7	Total	Average
It is important that I feel at home with the content	0	0	1	0	1	2	4	8	**6**
It is important that consuming content is easy and enjoyable	0	0	0	1	0	4	3	8	**6.13**
It is important that content in the service is entertaining	0	0	0	2	1	3	2	8	**5.63**
It is important that threshold to share content in the service is low	0	1	1	1	1	2	2	8	**5**
I can spend my time consuming content in the service	0	2	0	1	1	1	2	7	4.71
I get inspiration from other users content for creating my own content	1	1	0	1	2	1	2	8	4.63
Consuming content is easy in the service	0	0	0	4	2	0	2	8	**5**
It is fun to find new content offered by other users	0	0	0	0	4	2	2	8	**5.75**
I find content that interests me from the service	0	0	0	1	3	3	1	8	**5.5**
In the service it is easy to start sharing and consuming content	0	0	1	2	1	3	1	8	**5.13**
Total	1	4	3	13	16	21	21	79	**5.35**

Participants answers to statements concerning the field enjoyment

Answer the following statements on a scale 1-7 (1= Completely disagree, 7 = Completely agree)

	1	2	3	4	5	6	7	Total	Average
It is important that I can be creative in the service	0	0	0	2	1	2	3	8	**5.75**
It is important that I can express myself with the aid of shared content	0	0	0	2	2	2	2	8	**5.5**
It is important that I can trace my doings and content I have shared in the service	0	1	2	1	0	2	2	8	4.75
I am motivated by the own content creating to the service	0	0	1	1	2	1	3	8	**5.5**
I want to express myself in the service	0	0	3	0	1	2	2	8	**5**
I am interested to see who are looking at my content	0	3	0	0	1	2	2	8	4.63
It is important that I can tell new things to others and guide or teach them	1	0	0	0	3	2	2	8	**5.25**
I am able create content to the service community	0	0	0	0	5	2	1	8	**5.5**
I can see history about the things I have previously done in the service	0	0	1	3	2	0	2	8	4.88
I can show my skills through the content I share	0	2	0	1	2	1	2	8	4.75
I can tell and express things that I want in the service	0	1	0	0	3	2	2	8	**5.38**
With the aid of the service I can track how popular the content I have created is	1	1	0	1	2	0	2	7	4.43
I can see from the service who are looking at my content	1	1	0	1	2	2	1	8	4.5
I can tell and teach other users new things	0	0	1	2	3	0	2	8	**5**
Total	3	9	8	14	29	20	28	111	**5.06**

Participants answers to statements concerning the field self-expression

Answer the following statements on a scale 1-7 (1= Completely disagree, 7 = Completely agree)

	1	2	3	4	5	6	7	Total	Average
It is important that I can learn new things through other users contents	0	0	0	0	3	3	2	8	**5.88**
Popularity my content has reached interests me	1	2	0	1	1	1	2	8	4.25
I can tell things that I want in the service	0	0	1	1	3	1	2	8	**5.25**
I would like to tell and share things that I want to my acquaintances through the service	0	0	1	1	3	0	3	8	**5.38**
It is important that offered content is meaningful to me	0	0	0	0	4	1	3	8	**5.88**
I can learn new things with the help of content others have added	0	0	0	0	3	2	3	8	**6**
It is fun to browse content service has offered to me	0	1	0	1	2	2	2	8	**5.25**
I recieve enough information about the content I have consumed in the service	0	0	0	4	1	2	1	8	**5**
Service makes easier to find interesting content others have produced	0	0	1	1	1	4	1	8	**5.38**
I can find useful content from the service produced by others	0	0	1	0	0	5	2	8	**5.88**
Total	1	3	4	9	21	21	21	80	**5.41**

Participants answers to statements concerning the field discovery

Answer the following statements on a scale 1-7 (1= Completely disagree, 7 = Completely agree)

	1	2	3	4	5	6	7	Total	Average
It is important that I can share content to audience of my choosing through the service	0	0	0	1	2	3	2	8	**5.75**
It is important that through the service I can share content to audience as wide as possible	1	2	0	1	1	2	1	8	4.13
It is important that I can focus my content to right audience	0	0	0	2	1	2	3	8	**5.75**
I can delimit audience in the service	0	0	0	1	4	2	1	8	**5.38**
Way the service offered to share content was suitable for me	0	0	0	1	5	1	1	8	**5.25**
It is important that I can form smaller groups to share content to	0	0	0	2	2	2	2	8	**5.5**
I feel that I can control my content in the service	0	0	0	1	2	4	1	8	**5.63**
I feel that I can control the publicity of my content in the service	1	0	0	3	0	2	2	8	4.88
Privacy limitations were clear	1	0	1	1	1	2	2	8	4.88
Privacy limitations were sufficient	1	0	1	1	2	1	2	8	4.75
I feel that my content is safe in the service	0	1	1	2	1	2	1	8	4.63
I can delete my content if I so choose	0	1	0	0	2	2	3	8	**5.63**
Forming groups or adding friends was easy	1	0	0	2	3	1	1	8	4.63
I can reach through the service the audience I want	0	1	0	2	2	2	1	8	4.88
I would like to use the service in the future also	0	0	0	2	2	2	2	8	**5.5**
I could recommend the service to my friends	0	0	0	1	2	3	2	8	**5.75**
I liked the idea of the service	0	0	0	2	0	2	4	8	**6**
Total	5	5	3	25	32	35	31	136	5.23

Participants answers to statements concerning the field audience and privacy

APPENDIX E: TAMWARE STUDY NUMERIC ANSWERS

Background information concerning related technology

In general how familiar are you with technology?

1 - I am a beginner, 7 - I am an expert

1	2	3	4	5	6	7	Average
1	0	0	1	2	1	2	**5**

How accustomed you are with using devices with touch screens?

1 - I have not used any, 7 - I use daily

1	2	3	4	5	6	7	Average
0	2	0	0	0	1	4	**5,4**

How familiar are you with different map services?

1 - I have not used any, 7 - I use daily

1	2	3	4	5	6	7	Average
1	0	1	1	2	2	0	**4,3**

How often do you use local public transportation?

Daily	**1**
Several times a week	**4**
Several times a month	**1**
Monthly	**1**
Less than monthly	**0**

Scenario 1

How did the task feel?

1 - Extremely challenging, 7 - Extremely easy

1	2	3	4	5	6	7	Average
0	0	3	0	1	0	3	**5**

How did you perform in the task?

1 - Extremely poorly, 7 - Extremely well

1	2	3	4	5	6	7	Average
0	1	0	2	0	3	1	**5**

How did Smart Hub support you in your task?

1 - Extremely poorly, 7 - Extremely well

1	2	3	4	5	6	7	Average
0	1	3	1	1	0	1	**3,9**

Scenario 2

How did the task feel?

1 - Extremely challenging, 7 - Extremely easy

1	2	3	4	5	6	7	Average
0	1	1	2	0	1	2	**4,7**

How did you perform in the task?

1 - Extremely poorly, 7 - Extremely well

1	2	3	4	5	6	7	Average
0	0	1	0	2	2	2	**5,6**

How did Smart Hub support you in your task?

1 - Extremely poorly, 7 - Extremely well

1	2	3	4	5	6	7	Average
0	3	1	0	0	1	2	**4,1**

Scenario 3

How did the task feel?

1 - Extremely challenging, 7 - Extremely easy

1	2	3	4	5	6	7	Average
1	1	1	0	1	2	1	**4,3**

How did you perform in the task?

1 - Extremely poorly, 7 - Extremely well

1	2	3	4	5	6	7	Average
0	2	0	1	1	3	0	**4,4**

How did Smart Hub support you in your task?

1 - Extremely poorly, 7 - Extremely well

1	2	3	4	5	6	7	Average
0	2	2	1	2	0	0	**3,4**

Scenario 4

How did the task feel?

1 - Extremely challenging, 7 - Extremely easy

1	2	3	4	5	6	7	Average
0	0	4	1	0	0	2	**4,3**

How did you perform in the task?

1 - Extremely poorly, 7 - Extremely well

1	2	3	4	5	6	7	Average
1	1	0	2	1	0	2	**4,3**

How did Smart Hub support you in your task?

1 - Extremely poorly, 7 - Extremely well

1	2	3	4	5	6	7	Average
0	3	2	0	0	0	2	**3,7**